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OIL
INDUSTRY
OUTLOOK

BY

ROBERT J. BECK

ECONOMICS EDITOR

THE OIL & GAS JOURNAL

OIL INDUSTRY OUTLOOK

SIXTH EDITION 1990-1994

Oil Industry Outlook
Sixth Edition
by Robert J. Beck, Economics Editor, *Oil & Gas Journal*

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FOREWORD

Even a casual observer of the "state of mind" of the petroleum industry must have noted a subtle change in 1989. A new breeze was blowing—a fresh breeze signifying a more sanguine outlook. The statistics reflected the new but cautious confidence; rig usage was up and budgets reflected the modest increases in cash flow. There were other causes. The industry is recovering from the shock of 1986; it is learning to live with lower wellhead prices; and wellhead prices, although not stabilized, seem to have the potential for increases in the future.

Price volatility is still with the industry as evidenced by the past five years of wellhead prices for crude.

	Average U.S. Wellhead Price	Percent Change From Prior Year
1985	$24.09	- 7%
1986	12.51	-48%
1987	15.41	+23%
1988	12.57	-18%
1989	15.00 (est)	+19%

In the past five years, there have been three negative changes, from 7 to 48%, and two positive changes, from 19 to 23%. Except for the era of prorationing under the Texas Railroad Commission (and similar agencies of other states), volatility has been the norm for prices at the wellhead. Managements of companies are beginning to realize that they must learn to live with price volatility.

The lower prices for crude oil, worldwide, have resulted in increases in demand for petroleum products. U.S. demand for petroleum products for 1989 increased modestly, compared to recent years. The increased demand coupled with decreased U.S. production resulted in a sharp increase in imports of crude and products. In 1989, imports of crude oil and petroleum products reached more than 8 million b/d, about 45% of total demand; and imports as a percent of total demand will increase in the years ahead.

The handwriting has been on the wall for more than a decade. It can be expressed in simple terms: the U.S. consumes more than 6 billion barrels per year of crude and products; it produces only about 3.5 billion barrels of crude, condensate and natural gas liquids from existing fields; and it is finding less than one billion barrels per year in new oil fields. Our national leaders will have to learn to cope with higher levels of imports.

Drilling for natural gas is one of the bright spots for the industry in 1989. Gas well completions for 1989 are expected to be up about 5% to roughly 9,000 completions in 1989. The reemergence of relatively long-term gas contracts is another positive indication of better times ahead.

As cash flow increases, capital spending should increase slowly as management envisions a better future. Such increases will enhance the profits of all related segments of the upstream side of the industry. Service companies will show greater profits. The benefits of restructuring for service companies and other segments of the petroleum industry are being reflected in a greater survival rate of companies who managed to make it through the cash crunch of the past four years.

The media has duly recorded the comments of various leaders of companies in the U.S. who have announced a shift in emphasis in exploration to areas outside the U.S. However, the demise of the domestic onshore industry is not at hand. When corrected for future revisions (based on experience in the area), discoveries in major basins (on an oil-equivalent basis) have remained fairly stable. Excellent opportunities remain in the lower 48 states for the careful explorer.

The tremendous increase in activity of the 1980-1981 period brought an increase in the number of marginal discoveries. When the cash crunch arrived, the reduced spending levels precluded investments in marginal prospects. Marginal pospects add few reserves; so the sharp reduction in activity beginning in 1986, although reducing the number of discoveries, did not reduce the level of reserve additions commensurately.

Because of a better outlook in the minds of management, new hiring is taking place, although slowly. With experience levels down because of massive retirements and restructuring, training will be emphasized with renewed vigor in the next few years. Intense training is also necessitated by the rapid change in the state of the art for geologists, geophysicists and engineers. Current professionals employed by the industry will have greater needs for continuing training programs than their predecessors.

The most discernable trend is concern for the environment. The events in Prince William Sound show how quickly a backlash of intense feeling can affect an entire industry. The short-term effects were notable in 1989. The long-term effect will be new legislation of all types aiming at the impossible dream—a risk-free society. The excellent record of the petroleum industry in safe operations and safe transportation (99.9 + %) of crude oil and products was quickly obscured by a single accident. The outlook for the industry is one of increasing scrutiny by all environmental groups. Every program, every investment, and every operation must be rechecked for environmental safety. Events of 1989 indicate the strong public agreement on the need to address—now—all environmental issues.

All in all, 1989 was a good year for the petroleum industry. Prices were up, activity was up, and the new, smaller organizations are beginning to take hold. The year 1989 will not be recorded as a great year for the petroleum industry, but as a *turnaround* year.

Increases in demand for natural gas and crude oil plus some price optimism should see the petroleum industry start the long comeback toward a healthy profitable segment of the business community.

Robert E. Megill
Kingwood, TX
November, 1989

INTRODUCTION

Like being in the eye of a hurricane, the worldwide oil and gas industry is going through a period of uneasy calm, with a great deal of concern for what lies ahead. Compared to the recent past this has been a year of tranquillity. But the storm clouds are looming dark on the horizon and nobody expects the calm to last for long.

Over the past several years volatile and frequent changes have plagued planning for the worldwide oil and gas industry. Just when it appeared that the industry might be settling into a more predictable state, problems arose that made old projections obsolete and new forecasts uncertain. The worldwide and U.S. oil and gas industries continue to be reshaped by changing political and economic events. Profitable survival by those in the industry is dependent upon being aware of these changes and how they will shape the future. This outlook is being produced to provide some guidance and to assist in assessing the route to the future.

Over the past year crude oil prices have been relatively stable. Demand has been staying one step ahead of OPEC over production, and balancing the market. Non-OPEC supply has contributed to the market balancing act by declining due to problems in the U.S. and U.K.

The volatile shifts in crude oil prices have been the most unsettling events for the industry over the past few years. After sliding slowly downward for over four years, the price of crude oil fell precipitously in 1986. The price fell to levels that most industry observers would have never expected to see again. OPEC's adoption and adherence to a new production quota boosted prices in late 1986 and into 1987. Crude prices remained relatively stable throughout 1987. And it appeared that OPEC had adopted a policy that would provide a floor for oil prices and a base for future forecasts. However, the OPEC quota agreement proved to be rather fragile. Several individual OPEC countries exceeded quotas and prices fell rapidly again in 1988. OPEC reset the quotas and managed to control production levels enough to give a boost to prices in 1989. Relatively low prices boosted demand for petroleum in 1988 and 1989 and this helped sustain the higher price level. And even though there was overproduction on the part of some OPEC countries, it was not sufficient to put downward pressure on prices until late in the year. This resulted in price stability this year, but where prices will be in future years is still dependent on OPEC's ability to select a market clearing quota level and adhere to it.

The shift in control of the level of total worldwide crude oil production to OPEC resulted in a much less predictable industry. And it resulted in the major reason for price instability today: the massive excess crude production capacity. Aggressive OPEC pricing in the 1970's and early 1980's resulted in a rapid reduction in petroleum product demand. And this resulted in the development of the overhanging excess capacity.

It is still uncertain when this overhanging surplus will be eliminated and alleviate the downward pressure on prices. Lower product prices stimulate demand. If prices remain relatively low and demand continues to move up, it would go a long way toward significantly closing the surplus production gap.

At the lower price levels, the volume of higher cost non-OPEC production has been adversely affected. Development of the higher cost areas has been curtailed or delayed. The impact on U.S. domestic exploration and production has been substantial. Environmental concerns have added to the uncertainty of developing domestic resources.

Exploration and development drilling in the U.S. hit a record weekly low in the summer of 1986, and a record annual average low in 1989. The sharp drops in prices in 1986 and 1988 have led to a general feeling of uneasiness and have depressed investment in exploration and drilling. Some of the investment has shifted to non-U.S. areas with lower cost production, but even the international drilling activity has been affected by the volatility in prices.

The refining sector of the industry is also undergoing substantial change. The increase in product demand has increased the utilization rate and profitability of refining. Some of the OPEC producing countries are now investing in downstream operations. The impact of these investments is still a major unknown for the refining industry.

This is only a partial list of events that are presently shaping the industry and that will have a profound impact on the future of the industry.

Change and uncertainty are recurring themes. They are not new to the oil industry. Anyone close to the oil industry will tell you that the only thing certain about the oil industry is change, uncertainty and risk. In today's oil industry environment the entire foundation for making projections, forecasts and decisions is unstable. About the only thing that is certain is that the future industry will not look like the past. And that means any new investment entails substantial risk: the risk inherent with change.

Even in the face of all this uncertainty, forecasts have value. Forecasts are a valuable, essential tool for decision making. The 'bottom line' for the forecasting industry is a better decision. The more information obtained to assist operating and investment decisions, and the clearer the understanding of potential future events that will affect the industry, the more likely that a decision will make a positive contribution to a company's performance. A decision is seldom, if ever, 100% right or wrong. The outcome is usually some gradation of right or wrong. Any information that can improve the decision and increase the overall return on the company's investment is a valuable addition.

Forecasts and projections can be useful tools that help reduce risk. But in order to be a useful tool, a forecast must be based on an understanding of recent events and their effect on the industry. It must be internally logical and consistent, and it must use tried and tested economic theory as a framework.

Any forecast must be founded on a set of assumptions. It is essential that the basic assumptions used and conclusions drawn are logical, and hold together based on an understanding of the industry. It is essential that they reflect the actual workings of the industry and the economic system.

The industry is changing, but the outcome is still determined by basic economic principles. Recent events may be shaping the future industry, but historical relationships should not be discarded. Political, noneconomic events can upset the best forecast. But if a forecast is to be an aid in decision making, it must be based on known economic relationships rather than imagined future political events.

This outlook booklet has been developed to provide industry decision makers and analysts with a number of useful analytic tools. It is an outlook for the worldwide and domestic oil and gas industry for the next five years. It is a review of recent events that have had a major impact on the industry. And it is a guide to the factors to consider when preparing your own forecast for decision making.

In addition, the booklet provides the essential oil and gas industry historical data for additional individual analysis. This enables the adoption of an alternative set of assumptions and the development of alternative outlooks. Although a decision must be based on one perception of the future, a set of alternative assumptions and forecasts often aids decision making. Alternative outlooks can provide the framework for accessing the penalties or rewards from being wrong about the future.

In order to operate profitably in the future it is essential that companies develop a strategy for adapting to the changes occurring in the industry and a strategy for operating under the new conditions in the industry. The strategy that worked in the 1970's and 1980's will not necessarily work in the 1990's.

This *Outlook* and future editions will be of assistance in clarifying recent events and trends, and providing a logical and consistent outlook. The future may be filled with uncertainty, but it is also filled with exciting opportunities. The only way to take advantage of opportunities is to make decisions and take risks. This booklet has been prepared to help reduce risks and make the decisions more profitable.

WORLDWIDE OUTLOOK—DEMAND

■

Worldwide petroleum demand has always been one of the major determinants of trends in the oil and gas industry. It was particularly important over the last couple of years. The increase in demand played a major role in balancing the market and somewhat stabilizing prices. This outlook will start with a close look at the worldwide oil industry and worldwide energy and petroleum demand.

To a substantial extent the oil industry is a global rather than regional industry. Therefore, the initial focus will be on the recent trends in the worldwide industry. And this will be expanded into a global outlook, which would be the basis for a regional projection.

The U.S., European, or any other regional oil industry, is closely interrelated with activities in the worldwide industry. Any regional analysis must give consideration to the impact of worldwide economic and energy industry events.

First, there will be a look at trends in demand for petroleum products and the key factors that determine the level of petroleum product demand. These recent trends and relationships could be the determinants of future product demand. Once the present situation in the industry has been established, it will be followed by a presentation of the outlook for worldwide demand for energy and petroleum products for the next five years, 1990–1994.

The level of worldwide economic activity is the key determinant of energy and oil product demand. Energy is an essential input for all types of economic activity. Therefore, there is an extremely close relationship between economic activity and energy consumption. Although the relationship has changed over time, and has been rather volatile recently, as long as there is economic activity energy will be consumed in some quantity and form. And in today's modern economic systems and high levels of economic activity, vast quantities of energy are consumed, in a wide variety of forms and sources.

There are several basic energy sources and two of the most important basic energy sources are oil and natural gas. Oil products and natural gas are consumed throughout the world in a wide variety of areas with differing levels and types of economic activity. Oil products are consumed throughout the world, in the industrial economies, the developing economies, and the centrally-planned economies of the communist countries.

In all areas of the world demand for oil products and natural gas to fuel economic activity is the determinant of the level of activity in the oil industry. Therefore, energy needs and natural gas and petroleum product demand throughout the world have been analyzed as a basis for this outlook.

With the close relationship between economic activity and energy consumption, it becomes apparent that expectations for the future level of worldwide economic activity are the key determinants of the future demand for oil and gas.

But the price of energy in general and of the individual forms of energy, such as oil and natural gas, also plays a major role in determining the level of demand. The relationship between economic activity and energy consumption was altered dramatically over the past ten to fifteen years, because of the volatility of the cost/price of energy. The rapid increase in the cost of oil, and energy in general, broke the lock-step relationship between economic growth and energy consumption. With much higher prices for energy and petroleum products, conservation became a dominant factor determining the level of energy and oil consumption.

This ever-changing relationship is reviewed and projected in the following sections. And price, one of the key determinant variables of the future level of activity, is also reviewed and projected.

REVIEW

ECONOMIC ACTIVITY. As mentioned, the level of worldwide economic activity is the key determinant of energy demand. Therefore, a review of recent trends in economic activity is appropriate in analyzing and establishing the recent link with energy consumption.

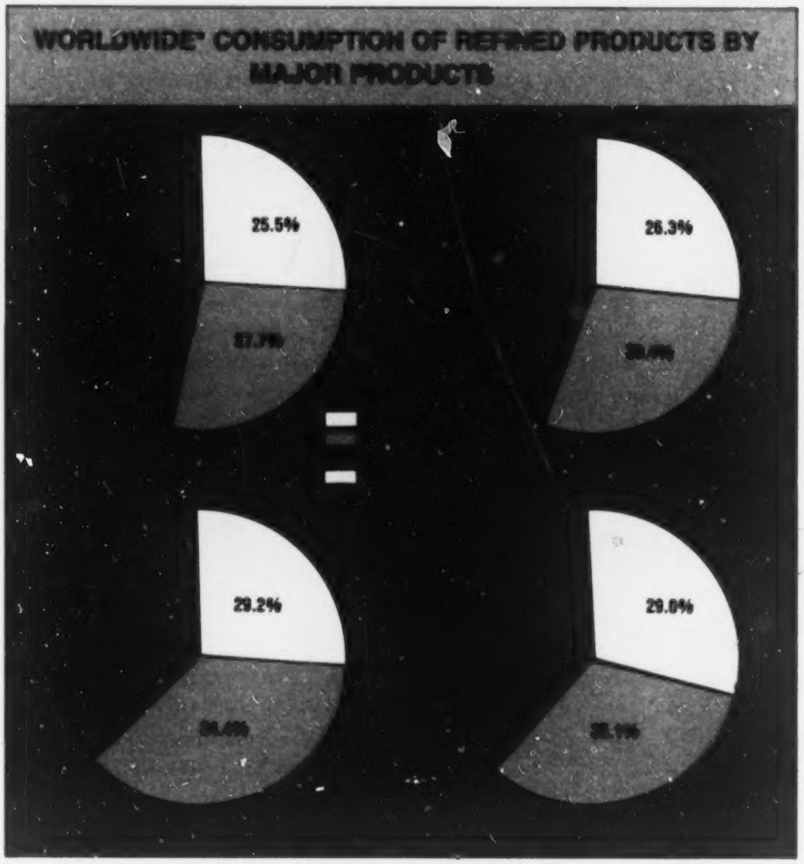
There is no aggregate measure of overall world economic activity. The statistics required to measure overall economic activity in many of the developing areas are not collected or even available. Only rough estimates can be made of the level of activity. There are some regional measures, but mainly for the industrial countries.

Aggregate economic activity is measured for the countries in the Organization for Economic Cooperation and Development (OECD). This is a group of 24 industrial countries. Overall, economic activity for this group increased in 1987 after slumping for two years 1985–1986. The growth of real GNP/GDP moved up to 3.4% from 2.8% in 1986. The rate of growth increased to 4.1% in 1988. Lower energy prices can be given some credit for stimulating economic growth since 1986.

Japan, Canada, Italy, United States and United Kingdom led the way among the larger countries. Japan's growth rate moved up to 5.7% in 1988, from 4.5% the year before and only 2.4% in 1986. Canada posted a growth rate of 4.5%, compared to 4% in 1987 and only 3.2% in 1986. Italy had a 3.9% growth rate, up from 3% in 1987 and 2.5% in 1986. Economic growth in the U.S. moved up to 3.9% compared to 3.4% the year before and 2.8% in 1986. And the U.K. posted 3.7% in 1988. This was down from 4.6% in 1987 but higher than the 3.2% in 1986.

Germany's economic growth rate moved up to 3.4% from only 1.8% in 1987, and 2.3% in 1986. France also recorded 3.4%, up from 1.9% in 1987 and 2.3% the year before.

The group of smaller European countries had an aggregate economic growth rate of 3.3% up from 2.9% in 1987 and 2.7% in 1986. Australia's rate dropped slightly in 1988 to 3.8% from 4.5% in 1987. But it was up from only 2.1% in 1986. New Zealand's growth rate moved up to a positive 0.3% in


WORLDWIDE* CONSUMPTION OF REFINED PRODUCTS BY MAJOR PRODUCTS

WORLDWIDE PETROLEUM PRODUCT MARKET SHARE

	1973 (%)	1976 (%)	1979 (%)	1982 (%)	1985 (%)	1988 (%)
U.S. and CANADA						
Gasoline	37.6	38.5	37.3	41.5	42.2	41.7
Middle distillates	25.2	25.7	27.0	26.9	28.7	29.0
Fuel oil	18.4	18.0	17.1	12.9	9.2	9.3
Other	18.8	17.8	18.6	18.7	19.9	20.0
Total	**100.0**	**100.0**	**100.6**	**100.0**	**100.0**	**100.0**
WESTERN EUROPE and JAPAN						
Gasoline	17.2	18.5	19.4	21.4	23.0	23.8
Middle distillates	29.4	30.8	32.0	33.9	37.4	38.8
Fuel oil	40.5	38.4	35.4	29.8	23.5	22.4
Other	12.9	12.3	13.2	14.9	16.1	15.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
REST OF WORLD*						
Gasoline	19.1	18.6	19.0	19.7	20.3	19.4
Middle distillates	29.0	32.7	33.6	36.2	37.9	38.4
Fuel oil	37.8	34.6	33.9	30.1	27.2	26.3
Other	14.1	14.1	13.5	14.0	14.6	15.9
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
TOTAL WORLD*						
Gasoline	25.5	26.4	26.3	26.1	29.2	29.0
Middle distillates	27.7	29.2	30.4	32.0	34.4	35.1
Fuel oil	31.5	29.6	28.0	23.9	19.4	18.8
Other	15.3	14.8	15.3	16.0	17.0	17.1
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

*Excludes communist areas

Source: British Petroleum

1988 after two years of recession, -0.1% in 1987 and -3.5% in 1986.

As can be seen there were wide-ranging differences in the growth rates between the OECD countries in 1988. But all but two, Denmark, -0.2%, and Iceland -1.4%, posted positive rates.

The aggregate growth rate for these countries has moved up since 1986, stimulated by the availability of lower cost energy. However, the internal cost of energy is determined by many factors and is not the same in each country.

The OECD economic growth rate for 1988, 4.1%, was considerably higher than the long term rate of about 2.5% per year. But this rate has not been constant and the OECD has gone through a number of cycles. The cost of energy has been responsible for some of the cyclical nature of that economic growth.

Over the period of 1972 to 1982, aggregate real economic growth for the total group of countries averaged 2.5% per year. The most recent economic recession hit a trough in most of the industrial countries during the fourth quarter of 1982. Aggregate economic activity for the OECD was down 0.5% in 1982.

An upturn in economic activity started slowly in 1983. Real economic growth for the OECD group was 2.7% in 1983. The rate of growth accelerated in 1984, and the OECD total economic activity increased 4.9%. Economic growth slowed a bit in 1985 and 1986 with OECD aggregate activity up 3.2% and 2.7% respectively.

The growth in the U.S. economy led the way in 1983 and 1984 as real U.S. GNP increased 3.6% in 1983 and 6.8% in 1984. But U.S.

economic growth slowed to 3.4% in 1985 and 2.8% in 1986.

Japan followed with an increase in economic activity of 3.2% in 1983 and 5.1% in 1984. Their growth slowed to 4.9% in 1985 and 2.5% in 1986. Canada posted a rate of economic growth of 3.2% in 1983, 6.3% in 1984, 4.3% in 1985 and 3.2% in 1986.

The United Kingdom posted a slightly different pattern with a 1983 rate of 3.3%, 1984 -2.6%, 1985 -3.6%, and 1986 +3.2%. Germany had a rate of 1.9% in 1983 that jumped to 3.3% in 1984, fell to 2.0% in 1985 and back up to 2.3% in 1986.

There are differences in the rates of growth and some differences in the cyclical patterns. But in general over this period there are striking similarities in the patterns of economic growth. Because of the increase in worldwide trade, the economic fortunes of all of the countries in the OECD appear to be closely related.

The rate of growth in economic activity for the entire OECD is estimated to be down slightly to 3.25% in 1989. But it is still positive and well above the average of 2.5%. The growth rate is expected to be lower in all of the large major industrial countries. Economic growth is expected to slip again in 1990, falling to 2.75%. Again the drop is expected in all of the major countries.

The growth rate for the seven largest industrial countries is estimated to be down to 3.25% in 1989 from 4.2%. This will drop to 2.75% in 1990. The growth rate for the remaining group of OECD countries is estimated to be down only marginally, to 3.25% from 3.3% in 1988. But it is projected to fall to 2.5% in 1990.

These are the major industrial countries of the world. And it should be noted that industrial activity tends to be more energy intensive than many other aspects of economic activity and therefore growth in this countries stimulates energy demand.

Economic growth in the developing countries is estimated to have slowed slightly in 1989 to 3.3%, from 4.2% the year before. But the growth rate is expected to move back up in 1990 to 4.2%. Low energy prices are particularly stimulating to economic growth in the developing countries. They do not have as many alternatives to help fuel their economies and they do not have the funds to invest in energy conservation.

WORLD OIL CONSUMPTION AND PRICE

Although lower energy prices helped the oil importing developing countries, they have had a less stimulating impact on the oil exporting countries. Energy-exporting developing countries have, until recently, accounted for around 40% of the combined economics activity of the developing countries. The energy exporting countries had an average economic growth rate of about 6.6% from 1971–1980. But from 1981–1989 the growth rate has averaged only 0.85%. However economic growth in these countries is expected to move up to 2.9% in 1990. For the non-energy exporting developing countries the growth rate was 5.2% in 1988 and an estimated 3.7% in 1989. It is expected to move up to 4.7% in 1990.

Offsetting lower energy prices is the depressing impact of huge budget deficits, huge worldwide debt and growing protectionism. All of these factors tend to slow economic growth. However, if these factors are kept under control without stimulating another round of worldwide inflation prospects for continued worldwide economic growth are quite good. A major key to economic growth is the level of investment. Investment can be stimulated if inflation is kept under control, and the debt burden is managed properly and slowly reduced.

This outlook is based on the expectation that these problems will not be eliminated but will be controlled and the world economy will continue to expand.

ENERGY. The relationship between economic growth and energy changed markedly after energy prices skyrocketed in the 1970's. Price-induced conservation reduced energy consumption throughout the industrial world. This was more pronounced in the years following the 1978–79 oil price hike.

WORLDWIDE PRIMARY ENERGY CONSUMPTION AND MARKET SHARE

(Million barrels oil equivalent)

	1974	% of total	1976	% of total	1979	% of total	1982	% of total	1984	% of total	1986	% of total	1987	% of total	1988	% of total
Oil	20,234	46.4	21,217	46.0	22,907	45.0	20,461	40.6	20,693	39.1	21,252	38.2	21,612	37.9	22,272	37.6
Natural gas	7,976	18.3	8,398	18.2	9,405	18.5	9,746	19.4	10,585	2.0	10,901	19.6	11,419	20.0	11,955	20.2
Coal	12,396	28.4	13,086	28.4	14,431	28.3	14,998	29.8	15,946	30.1	16,993	30.5	17,166	30.1	17,797	30.1
Water power	2,519	5.8	2,627	5.7	3,058	6.0	3,361	6.7	3,614	6.8	3,787	6.8	3,916	6.9	3,938	6.7
Nuclear	457	1.1	770	1.7	1,121	2.2	1,794	3.5	2,137	4.0	2,761	4.9	2,978	5.1	3,216	5.4
Total*	**43,582**	**100.0**	**46,098**	**100.0**	**50,922**	**100.0**	**50,360**	**100.0**	**52,975**	**100.0**	**55,694**	**100.0**	**57,091**	**100.0**	**59,178**	**100.0**

*Excludes miscellaneous fuels not mentioned specifically.

Source: British Petroleum

WORLDWIDE OIL CONSUMPTION

(1,000 b/d)

Country/Area	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	% change 88/73	% change 88/79
NORTH AMERICA																					
U.S.*	14,350	14,845	15,990	16,870	16,150	15,875	16,980	17,925	18,255	17,910	16,460	15,550	14,765	14,745	15,175	15,170	15,670	15,955	16,420	–2.7	–8.3
Canada	1,525	1,585	1,655	1,755	1,785	1,735	1,790	1,810	1,835	1,915	1,855	1,760	1,565	1,475	1,425	1,490	1,475	1,540	1,615	–8.0	–15.7
Total North America	**15,875**	**16,430**	**17,645**	**18,625**	**17,935**	**17,610**	**18,770**	**19,735**	**20,090**	**19,825**	**18,315**	**17,310**	**16,330**	**16,220**	**16,600**	**16,660**	**17,145**	**17,495**	**18,035**	**–3.2**	**–9.0**
WESTERN EUROPE																					
Austria	185	205	215	235	210	215	230	225	240	250	245	225	210	205	200	200	215	220	220	–6.4	–12.0
Belgium & Luxembourg	560	570	620	635	560	535	560	565	585	560	540	500	475	435	420	430	485	490	500	–21.3	–10.7
Denmark	365	365	385	360	320	315	335	330	325	320	275	260	225	215	210	220	215	200	195	–45.8	–39.1
Finland	210	220	235	260	230	235	255	250	250	265	255	245	230	215	215	220	230	230	230	–11.5	–13.2
France	1,920	2,090	2,315	2,585	2,460	2,255	2,430	2,350	2,445	2,435	2,260	2,060	1,915	1,880	1,815	1,790	1,830	1,845	1,820	–29.6	–25.3
Greece	135	150	170	200	185	195	210	215	230	250	250	240	240	230	235	245	250	270	285	42.5	14.0
Iceland	10	10	10	15	15	10	10	10	10	15	10	10	10	10	10	10	10	10	10.0	–33.3	–33.3
Republic of Ireland	80	90	100	110	110	105	105	115	125	130	120	105	95	85	85	85	100	85	80	–27.3	–38.5
Italy	1,740	1,875	1,965	2,070	2,015	1,895	2,065	1,920	2,015	2,080	1,970	1,940	1,845	1,820	1,735	1,730	1,770	1,850	1,880	–9.2	–9.6
Netherlands	725	720	805	835	725	710	795	770	795	855	800	745	655	625	625	635	700	705	740	–11.4	–13.5
Norway	165	165	170	175	160	165	180	180	195	200	200	190	180	180	190	200	200	215	205	17.1	2.5
Portugal	95	115	120	130	135	140	145	150	150	165	170	180	195	195	195	180	195	190	175	34.6	6.1
Spain	565	635	655	790	820	865	970	930	955	1,015	1,070	1,040	990	1,010	955	925	925	925	930	17.7	–8.4
Sweden	590	560	565	585	540	535	590	560	535	545	500	455	420	375	360	375	385	355	345	–41.0	–36.7
Switzerland	260	275	280	300	270	260	270	270	280	270	270	250	235	260	250	255	280	265	265	–11.7	–1.9
Turkey	155	180	200	250	255	275	310	340	315	300	300	315	335	330	370	345	375	435	460	84.0	53.3
United Kingdom	2,095	2,105	2,230	2,300	2,135	1,875	1,860	1,885	1,930	1,945	1,670	1,560	1,580	1,530	1,850	1,630	1,645	1,610	1,705	–25.9	–12.3
West Germany	2,655	2,745	2,885	3,070	2,760	2,655	2,855	2,855	2,960	3,050	2,725	2,465	2,355	2,340	2,330	2,391	2,530	2,445	2,435	–20.7	–20.2
Total Western Europe	**12,510**	**13,075**	**13,925**	**14,905**	**13,905**	**13,240**	**14,175**	**13,920**	**14,340**	**14,650**	**13,630**	**12,785**	**12,190**	**11,940**	**12,050**	**11,865**	**12,340**	**12,345**	**12,480**	**–16.3**	**–14.8**
AUSTRALASIA																					
Australia	510	535	540	590	610	605	630	655	655	665	630	625	610	590	610	590	610	635	650	10.2	–2.3
New Zealand	85	85	90	95	95	90	95	95	95	90	90	85	85	80	85	80	85	95	95	0.0	5.6
Total Australasia†	**595**	**620**	**630**	**685**	**705**	**695**	**725**	**750**	**750**	**755**	**720**	**710**	**695**	**670**	**695**	**670**	**695**	**730**	**745**	**8.8**	**–1.3**
Japan	4,000	4,435	4,735	5,460	5,270	5,020	5,190	5,350	5,420	5,485	4,935	4,695	4,395	4,390	4,565	4,380	4,435	4,435	4,760	–12.8	–13.2
Total OECD	**32,980**	**34,560**	**36,935**	**39,675**	**37,815**	**36,565**	**38,860**	**39,755**	**40,600**	**40,715**	**37,600**	**35,500**	**33,610**	**33,220**	**33,910**	**33,575**	**34,615**	**35,005**	**36,020**	**–9.2**	**–11.5**
Cyprus/Gibraltar /Malta	20	25	25	25	25	20	25	25	25	30	30	30	30	30	35	35	40	45	50	100.0	66.7
Latin America	2,645	2,820	3,060	3,355	3,495	3,520	3,570	3,820	3,975	4,230	4,400	4,435	4,540	4,450	4,420	4,425	4,530	4,740	4,825	43.8	14.1
Middle East	965	1,055	1,115	1,210	1,320	1,320	1,475	1,565	1,620	1,925	2,020	2,130	2,190	2,425	2,545	2,680	2,660	2,705	2,815	132.6	88.3
Africa	855	900	920	1,010	1,035	1,050	1,155	1,205	1,290	1,360	1,450	1,525	1,610	1,630	1,630	1,700	1,695	1,775	1,795	77.7	32.0
South Asia	540	565	585	635	600	610	665	705	760	775	825	890	935	950	1,030	1,160	1,210	1,260	1,370	115.7	76.8
Southeast Asia	1,005	1,110	1,255	1,430	1,475	1,490	1,630	1,755	1,965	2,245	2,280	2,325	2,250	2,260	2,265	2,225	2,395	2,545	2,890	102.1	28.7
Total NCW	**39,010**	**41,035**	**43,895**	**47,340**	**45,785**	**44,575**	**47,380**	**48,830**	**50,235**	**51,280**	**48,605**	**46,835**	**45,165**	**44,965**	**45,835**	**45,800**	**47,145**	**48,075**	**49,765**	**5.1**	**–3.0**
Socialist Countries																					
China	560	725	855	1,065	1,225	1,350	1,530	1,630	1,705	1,835	1,765	1,705	1,660	1,705	1,735	1,745	1,820	1,925	2,035	91.1	2.9
U.S.S.R.	5,310	5,655	6,115	6,595	7,280	7,520	7,780	8,125	8,480	8,640	8,975	9,085	9,030	8,905	8,890	8,885	8,930	8,920	8,890	34.8	2.9
Others	1,535	1,715	1,870	2,010	2,090	2,235	2,430	2,595	2,675	2,755	2,695	2,575	2,495	2,420	2,415	2,470	2,560	2,535	2,555	27.1	–7.3
Total Socialist Countries	**7,405**	**8,095**	**8,840**	**9,670**	**10,595**	**11,105**	**11,740**	**12,350**	**12,860**	**13,230**	**13,435**	**13,365**	**13,185**	**13,030**	**13,040**	**13,100**	**13,310**	**13,380**	**13,480**	**39.4**	**1.9**
Total World	**46,415**	**49,130**	**52,735**	**57,010**	**56,360**	**55,680**	**59,120**	**61,180**	**63,095**	**64,510**	**62,040**	**60,200**	**58,350**	**57,995**	**58,875**	**58,900**	**60,455**	**61,455**	**63,245**	**10.9**	**–2.0**

*U.S. processing gain has been deducted from local domestic product demand. †Includes Australia and New Zealand.

Source: British Petroleum

From a worldwide perspective the effects of conservation were partially offset by continued growth in the developing areas. In developing areas, conservation of energy has not been as evident as in industrial areas. In the developing areas, industrialization is still the major economic policy objective and supersedes any attempts at conservation. But in these areas higher energy prices slowed economic growth and therefore also resulted in lower energy consumption.

There has been a shift in this trend the past couple of years. The lower energy prices have helped slow conservation and the search for a more efficient use of energy. And the ratio of energy consumption to economic growth has moved up.

Over the long run the ratio of energy to gross economic output can be expected to continue to fall worldwide, and particularly in the industrial areas. However, the lower energy prices should continue to slow conservation efforts and the slow the rate of change in this ratio. This will be particularly true in those areas where lower energy costs are passed through to the user or consumer of energy.

World primary energy consumption has been on the rise again in recent years. Total world primary energy consumption moved up 2.4% in 1986 to 55.7 billion barrels of oil equivalent. It moved up another 2.5% in 1987 to 57.1 billion barrels of oil equivalent, and then jumped up 3.7% in 1988 to 59.2 billion barrels of oil equivalent.

World primary energy consumption moved up steadily through the 1950's, 1960's and 1970's to 50.97 billion barrels of oil equivalent in 1979.

WORLDWIDE PRIMARY ENERGY CONSUMPTION

Country/Area	1973	1976	1979	1982	1985	1987	1988	% change 88/73	% change 88/79
	(Million barrels oil equivalent)								
NORTH AMERICA									
U.S.	13,288.6	13,216.7	14,031.1	12,665.5	13,240.2	13,659.5	14,226.1	7.1	1.4
Canada	1,399.3	1,515.1	1,625.8	1,575.2	1,633.1	1,725.5	1,844.2	31.8	13.4
Total North America	**14,687.9**	**14,731.8**	**15,656.9**	**14,240.7**	**14,873.3**	**15,384.9**	**16,070.3**	**9.4**	**2.6**
WESTERN EUROPE									
Austria	174.5	173.7	193.5	178.9	184.7	199.4	195.7	12.1	1.1
Belgium & Luxembourg	372.4	365.0	374.6	337.2	352.6	376.0	385.6	3.5	2.9
Denmark	144.4	140.7	147.3	122.4	134.9	132.7	130.5	− 9.6	− 11.4
Finland	131.2	134.9	158.3	156.9	165.7	178.1	175.2	33.5	10.7
France	1,364.1	1,342.9	1,414.0	1,332.6	1,382.4	1,452.1	1,443.3	5.8	2.1
Greece	112.1	137.1	127.5	123.1	139.3	153.2	167.1	49.1	31.1
Iceland	15.4	15.4	13.9	11.0	11.0	11.7	11.7	−24.0	−15.8
Republic of Ireland	54.2	52.8	65.2	60.8	62.3	64.5	65.2	20.3	0.0
Italy	1,010.8	1,046.0	1,097.3	1,029.9	1,023.3	1,090.7	1,109.8	9.8	1.1
Netherlands	563.7	559.3	575.4	496.2	510.9	541.7	537.3	− 4.7	− 6.6
Norway	206.0	225.0	232.4	237.5	234.6	243.4	241.2	17.1	3.8
Portugal	66.0	64.5	82.8	90.9	78.4	87.2	82.8	25.5	0.0
Spain	423.7	494.0	552.7	554.9	571.0	589.3	624.5	47.4	13.0
Sweden	337.9	359.9	365.8	338.6	370.2	392.2	407.5	20.6	11.4
Switzerland	175.2	165.7	179.6	188.4	209.6	208.2	210.4	20.1	17.1
Turkey	131.9	166.4	171.5	203.0	228.0	348.2	379.0	187.3	121.0
United Kingdom	1,647.8	1,520.2	1,626.5	1,421.3	1,481.4	1,515.8	1,526.8	− 7.3	− 6.1
West Germany	1,941.7	1,902.9	2,103.7	1,829.6	1,962.2	1,956.4	1,960.0	0.9	− 6.8
Total Western Europe	**8,873.0**	[illegible]	**9,482.0**	**8,713.2**	**9,124.5**	**9,518.8**	**9,611.9**	**8.3**	**1.4**
AUSTRALASIA									
Australia	397.3	458.9	527.8	549.0	578.3	642.8	665.6	67.5	26.1
New Zealand	76.2	81.4	82.1	84.3	97.5	113.6	118.0	54.9	43.7
Total Australasia*	**473.5**	**540.3**	**609.9**	**633.3**	**675.8**	**756.4**	**783.6**	**65.5**	**28.5**
Japan	2,548.6	2,526.7	2,711.4	2,499.5	2,722.4	2,760.5	2,931.3	15.0	8.1
Total OECD	**26,583.0**	**26,665.2**	**28,460.2**	**26,086.7**	**27,396.0**	**28,420.6**	**29,397.1**	**10.6**	**3.3**
Cyprus/Gibraltar/Malta	10.3	9.5	11.0	11.7	14.7	17.6	19.1	85.4	73.6
Latin America	1,722.6	1,925.6	2,347.8	2,620.5	2,801.5	3,030.3	3,118.9	81.1	32.8
Middle East	658.2	752.8	941.2	1,059.9	1,321.6	1,365.6	1,428.6	117.0	51.8
Africa	719.1	862.0	1,106.1	1,337.0	1,403.7	1,478.5	1,539.3	114.1	39.2
South Asia	757.2	839.3	929.4	1,181.6	1,455.0	1,649.3	1,781.2	135.2	91.7
Southeast Asia	683.2	770.4	1,081.2	1,148.6	1,317.9	1,590.6	1,772.4	159.4	63.9
Total Non-Communist World	**31,133.6**	**31,824.8**	**34,876.9**	**33,445.0**	**35,710.4**	**37,552.4**	**39,056.6**	**25.4**	**12.0**
COMMUNIST									
China	2,657.1	3,206.1	3,931.8	3,834.3	4,644.3	5,068.0	5,326.7	100.5	35.5
U.S.S.R.	6,407.2	7,452.4	8,312.2	8,638.4	9,446.9	9,990.8	10,237.1	59.8	23.2
Others	3,161.4	3,642.3	3,989.0	4,028.6	4,234.5	4,480.1	4,558.5	44.2	14.3
Total Communist	**12,225.7**	**14,300.8**	**16,233.0**	**16,501.3**	**18,325.7**	**19,538.9**	**20,122.3**	**64.6**	**24.0**
Total World	**43,359.3**	**46,125.6**	**51,109.9**	**49,947.3**	**54,036.1**	**57,091.3**	**59,178.9**	**36.5**	**15.8**

*Includes Australia and New Zealand.
Source: British Petroleum

WORLDWIDE PETROLEUM PRODUCT CONSUMPTION

	1973	1976	1979	1982	1985	1987	1988	% change 79/73	% change 88/79	% change 88/73
	(Million barrels)									
U.S. and Canada	6,609.5	6,657.8	7,022.9	5,705.7	5,792.2	6,119.1	6,332.4	6.3	−9.8	− 4.2
Gasoline	2,487.8	2,565.5	2,619.0	2,366.1	2,441.6	2,579.4	2,639.5	5.3	0.8	6.1
Middle distillates	1,663.2	1,712.3	1,893.3	1,537.1	1,663.9	1,747.5	1,834.7	13.8	− 3.1	10.3
Fuel oil	1,214.6	1,201.4	1,198.5	737.4	534.4	554.1	590.8	− 1.3	−50.7	−51.4
Other	1,243.9	1,178.7	1,312.1	1,065.1	1,152.3	1,238.0	1,267.4	5.5	− 3.4	1.9
Western Europe and Japan	7,461.9	6,954.0	7,181.9	5,832.5	5,629.4	5,799.5	5,983.5	− 3.8	−16.7	−19.8
Gasoline	1,285.7	1,285.7	1,396.4	1,250.5	1,293.0	1,382.4	1,422.9	8.6	1.8	10.6
Middle distillates	2,196.1	2,144.0	2,300.2	1,976.9	2,107.4	2,240.0	2,323.6	4.7	1.0	5.8
Fuel oil	3,023.6	2,668.1	2,545.0	1,738.7	1,321.6	1,249.0	1,342.1	−15.8	−47.3	−55.6
Other	956.5	856.1	940.4	866.4	907.5	928.0	895.7	− 1.7	− 4.8	− 6.4
Rest of World*	3,008.2	3,346.1	4,042.5	4,344.5	4,531.4	4,831.2	5,082.6	34.4	25.7	69.0
Gasoline	574.7	622.3	768.9	853.9	921.4	943.4	985.2	33.8	28.1	71.4
Middle distillates	872.3	1,093.6	1,356.8	1,574.5	1,717.4	1,846.4	1,949.8	55.5	43.7	123.5
Fuel oil	1,136.9	1,158.1	1,369.2	1,309.1	1,234.4	1,267.4	1,337.7	20.4	− 2.3	17.7
Other	424.3	472.1	547.6	606.9	658.2	774.0	810.0	29.0	47.9	90.9
Total World*	17,079.6	16,958.0	18,247.3	15,882.6	15,953.0	16,749.8	17,398.5	6.8	− 4.7	− 1.9
Gasoline	4,348.2	4,473.5	4,784.3	4,470.6	4,656.0	4,905.2	5,046.7	10.0	5.5	16.1
Middle distillates	4,731.6	4,949.9	5,550.3	5,088.5	5,488.7	5,833.9	6,108.1	17.3	10.0	29.1
Fuel oil	5,375.1	5,027.6	5,112.7	3,785.2	3,090.3	3,070.5	3,270.6	− 4.9	−36.0	−39.2
Other	2,624.7	2,506.9	2,800.1	2,538.4	2,718.0	2,940.1	2,973.0	6.7	6.2	13.3

*Excludes communist areas Source: British Petroleum

During the ten-year span, 1969-1979, world energy consumption increased 51.6%, or at an average annual rate of about 4.2% per year. However, following the sharp increase in energy costs in the 1970's and early 1980's, a conservation effect was felt and energy consumption leveled off and fell. Energy consumption fell 1.0% between 1979 and 1981 to a recent low of 50.4 billion barrels of oil equivalent.

As energy prices began to slide, consumption increased, moving up marginally in 1982 and up 1.4% in 1983. Still lower energy prices and more vigorous economic growth helped boost energy consumption another 3.7% in 1984. It again moved up in 1985, 2.6%, to 54.5 billion barrels.

Most of the energy conservation took place in the non-communist countries. During the period 1979 through 1982, energy consumption fell 3.7%, from 34.7 billion barrels oil equivalent to 33.5 billion barrels in the non-communist countries. Over the same three year span, energy consumption in the communist countries moved up 4.9%. With the extensive network of controls, world prices had a lot less impact on energy consumption in the countries with centrally planned economies.

Energy consumption in the non-communist countries began to move up again as prices moderated, increasing 0.6% in 1983. It moved up 4% in 1984, 1.6% in 1985, 2% in 1986, 3.1% in 1987, and 4% in 1988. Since the recent low in 1982 energy demand has increased 16.8% through 1988. This is an increase of over 2.6% per year.

The conservation effect had the biggest impact on the industrial countries with energy-intensive economies. Between 1979 and 1983, U.S. energy consumption fell 10.2%, Western Europe energy consumption fell 8.1% and Japanese energy consumption fell 7.8%. Most of these countries were highly dependent upon oil to fuel economic growth, and the huge increase in oil prices provided substantial incentive for conservation.

Even with moderately lower energy prices, growth in energy consumption has been modest in these industrial areas. But the rate of growth has been picking up in some of the areas. North American energy consumption moved up 5% from 1982-1986, and then jumped up 2.9% in 1987 and 4.5% in 1988. Japan's energy use was up 6.2% in 1988. It had moved up 10.4% from 1982-1987.

In contrast, Western Europe's energy consumption was up only 1% in 1988. It had moved up 9.2% from 1982-1987. Many countries in Western Europe tax energy heavily and the drop in energy prices is not always passed through to the consumer.

With the combination of an upswing in overall economic activity and lower energy prices, energy consumption should be expected to increase in the near future. Conservation will continue to dampen demand, but this should be offset by the effect of lower prices and economic growth. The lower energy prices which the world is now experiencing should severely diminish the incentive for conservation and boost energy consumption.

There has been a substantial shift in the market share of the various forms of primary energy. Over the period 1972 through 1983, oil's share of total worldwide primary energy fell from 46% to 40.3%. It then dropped to 39.1% in 1984, and 37.8% in 1985. Lower oil prices helped boost it back up to 38.2% in 1986. Oil's share slipped to 37.9% in 1987 and 37.6% in 1988. The lower oil prices have slowed the decline in market share but have not stopped it completely.

Although there have been year-to-year fluctuations in relative market shares, all other primary fuels gained market share at the expense of oil over the period 1972-1985. The sharp drop in oil prices in 1986 changed this trend slightly, but the rebound in prices in 1987 set it back on course.

Natural gas moved up from 18.6% in 1972 to 20.0% in 1984, and 20.1% in 1985. The natural gas share slipped to 19.6% in 1986, but then moved back up to 20% in 1987, and 20.2% in 1988. Coal increased from 28.9% in 1972 to 30.1% in 1984 and 30.6% in 1985. Coal slipped to 30.5% in 1986, and then to 30.1% in 1987 and 1988. Nuclear power supplied only 0.7% of total energy in 1972, but moved up steadily since, to 4.0% in 1984, 4.6% in 1985, 4.9% in 1986, 5.2% in 1987, and 5.4% in 1988. Nuclear's increase has not been affected much by the rise and fall in oil prices. Hydroelectric power contributed 5.8% in 1972, 6.8% in 1984, and 6.9% in 1985. It slipped to 6.8% in 1986, moved back up to 6.9% in 1987, and fell to 6.7% in 1988. Hydroelectric output is very dependent upon weather conditions.

The rapid rise in the price of oil relative to other fuels led to fuel switching. This was particularly true for heavy industry and electric utilities. With the high price, oil became the "swing fuel," supplying energy when other fuels were not available. Total world energy consumption is up 43.7% over the 1972-1988 period, while energy from oil is up only 17.7%.

The rapid rise in oil prices made the consumers, worldwide, oil energy cost-conscious. Where possible, fuel switching to less costly fuels took place. In general, energy costs had risen enough to become a major concern in the economics of industrial production and in the cost of living, and substantial price-induced conservation took place.

During the next few years, oil's share of the total market will drop, but only marginally. The drop in crude prices has made oil more competitive with other fuel sources and also has slowed investment in conservation. Oil's share of the market may even increase and replace coal or natural gas in certain areas.

OIL PRODUCT DEMAND. Worldwide non-communist demand for oil products has gone through three phases over the past fifteen years. It followed two distinct trends between 1972 and 1983. From 1972 through 1979, free-world demand was on the rise, increasing 15.8% over this seven-year span. From 1979 through 1983, demand for oil fell as price-induced conservation took over. Consumption dropped 11.8% over this four-year time period. The net effect was that free-world demand in 1983 was only 2.2% above 1972.

There was a reversal of this downward trend in 1984 as lower prices and economic activity boosted demand 1.4%. Demand fell 1.1% in 1985, but moved up 3.3% in 1986, 1.5% in 1987, and 3.1% in 1988.

This could be the start of a new upward trend in oil demand. Lower oil prices, particularly real oil prices adjusted for inflation, are expected to combine with increased economic activity to boost demand throughout the near future.

A major factor lowering demand was price induced conservation which brought about increased oil-energy efficiency. In addition, fuel switching, due to the higher oil prices, had an impact. They both helped to reduce overall demand for petroleum products, and also changed the mix of petroleum products consumed. There was a shift to a higher percentage of light products since there was no convenient substitute for these. The heavier fuel oils ran into a number of less costly substitutes that could be used; natural gas and coal being the major competing fuels.

The competition is most intensive for fuel for electric power consumption and for industrial production. Therefore, the impact of competitive fuels is most evident in the consumption of heavy fuel oil. Consumption of heavy fuel oil in the non-communist world was 5.1 billion barrels in 1979. Demand fell 38.8% to 3.1 billion barrels in 1985.

The high prices for heavy fuel oil led to increased consumption of coal and in some areas, natural gas. In addition, the nuclear industry continued to grow, displacing demand for heavy fuel oil for electric power consumption. But sharply lower prices in 1986 proved that there is still a market for heavy fuel oil if the cost is competitive. Total non-communist consumption increased 2.7% in 1986 as low prices enabled heavy fuel oil to regain some market share from coal and natural gas. Prices moved back up in 1987 and demand fell again 3.4%.

This consumption pattern was mainly due to demand in the U.S. In the U.S. heavy fuel oil consumption fell 58.1% between 1977 and 1985. But demand rebounded in 1986 moving up 18%. Demand slipped again in 1987 falling 10.9%. With lower prices again in 1988 demand moved back up 9% and is at about the same level of consumption in 1989. Demand for heavy fuel oil in Western Europe fell 50.5% between 1976 and 1985. But consumption moved up 0.5% in 1986 on the strength of economic growth and lower prices. Demand slipped 5.9% in 1987 as priced moved back up, and then jumped back up 6.9% in 1988. In contrast, consumption in Japan continued to slide throughout 1986 and 1987, down 5.1% and 3.6%. But in 1988 consumption reversed the trend and moved up 8.6%.

As can be seen, lower fuel oil prices made fuel oil more competitive with other forms of energy. This may actually increase the demand for fuel oil in the near future as the industrial countries look for a fuel source for increased electric power generation. The key to the level of demand will be the level of prices relative to other competing fuels.

The changing pattern of demand wasn't quite as dramatic for the other major petroleum products. Gasoline consumption in the non-communist world hit a high in 1978 at 4.8 billion barrels. With higher prices demand fell rapidly, 6.9% to 4.4 billion barrels in 1982. But as prices slipped and economic growth continued demand moved back up steadily from 1982 through 1988. Demand in 1988 was 5 billion barrels up 11.2% from 1982. Demand in 1988 was 2.9% above 1987.

Demand in the U.S. also peaked in 1978 and then fell rapidly, 13% by 1982. Consumption in 1988 was up 1.8% from 1987 and up 12.2% from the recent low in 1982.

The pattern in Europe was similar. Gasoline consumption peaked in 1979, and then dropped abruptly, 9.1% by 1981. Demand has moved back up steadily since 1981. It moved up 1.9% in 1988 from 1986, and was 12.5% above 1981.

In the developing countries demand has continued to climb steadily throughout the 1970's and 1980's with only a slight slip in 1983 and 1984 due to the high prices. In these other areas demand moved up 4.5% in 1988 and was at a record high.

Middle distillate demand also rebounded in 1986 and continued to climb in 1987 and 1988. Non-communist consumption increased 3.9% in 1986, 2.1% in 1987, and 4.7% in 1988. All three years surpassed the previous peak year of 1979. Middle distillate demand slid 8.6% between 1979 and 1982. But with increased economic activity, middle distillate demand has been increasing over the years since 1982.

Consumption of all other petroleum products moved up 1.1% in 1988 to 3 billion barrels. Demand in 1988 was at a new record high.

As can be seen from this, there has been a major shift in petroleum product demand to a larger percentage of lighter products. The major reason has been the reduction in demand for fuel oil. But in addition, demand for middle distillates, motor gasoline, and other products has moved up along with economic growth.

Demand for petroleum products in the non-communist world peaked in 1979 at 18.7 billion barrels. This fell 10.7% to 16.7 billion barrels in 1985. The drop in fuel oil consumption accounted for 88.1% of the decline.

Total demand in 1988 was down 553 million barrels from the 1979 peak. Fuel oil demand in 1988 was down 1683 million barrels, accounting for more than the entire decline.

From a geographical perspective, the shift in product mix is most pronounced in the United States, Western Europe and Japan. In these areas there has been a major shift away from fuel oil and an increase in demand for gasoline and middle distillates. In the rest of the free world, the shift has not been as pronounced, but is also evident.

Over the period 1977 through 1988, the product demand mix changed markedly. In the U.S., the fuel oil share of the total barrel dropped from 18.6% in 1977 to 9.2% in 1988. Gasoline moved up from 38% in 1977 to 42.2% in 1988. And middle distillates increased from 25.9% to 28.6% in 1988.

In Canada the fuel oil share moved from 18.5% down to 10.2% in 1988. Gasoline consumption increased from 34.8% in 1977 to 36.5% in 1988. And middle distillates increased from 31.3% to 32.4%.

In Western Europe and Japan the drop in fuel oil demand was even more pronounced. In Europe, fuel oil demand dropped from 32.4% of the market in 1977 to 20.4% in 1988. Gasoline in Europe moved up from 19.1% to 24.8%. And middle distillates shifted from 35.3% to 40.4%. In Japan, fuel oil fell from 49.5% of oil product consumption in 1977 to 27.8% in 1988. Gasoline moved from 17.1% to 20.9%, and middle distillates from 21.4% to 34.5%.

There are obvious geographical differences, with gasoline being a much greater share of the North American market, and fuel oil relatively more important but diminishing in importance elsewhere.

Looking at product consumption from the geographical perspective, what stands out most is the difference in trends between the industrial countries and the other, less-developed, countries.

Total consumption in the U.S., Canada, Western Europe, and Japan was down 9.5% in 1988 from 1977. For the remainder of the non-communist world, consumption in 1988 was up 47.2% from 1977.

PRICES. As was mentioned in the introduction, there was an abrupt alteration starting in the 1970's of the relationship between economic activity and energy consumption. This alteration was primarily due to the rapid increase in the cost of oil and then other energy in the 1970's.

Oil, and other energy costs, increased more rapidly than other economic costs. This made energy a more important consideration in business decision making. The result was an adjustment in investment decisions with more concern for cost-cutting energy-saving investments.

This shift altered the emphasis of investment decisions; from investing for increased economic output for consumption, to an emphasis on energy cost cutting. This contributed to a drop in energy demand, but also slowed worldwide economic growth.

From 1972 to 1982, the posted price of Saudi Arabian marker crude increased from $2.48/bbl to $34/bbl, an increase of 1,271% or $31.22/bbl. The real price adjusted for inflation increased 546%. This far surpassed the average price increase for all commodities of 151% over this period.

The sharp increase in prices did not initially slow demand for petroleum products. There is some evidence that the price of crude oil was below the market equilibrium price in the 1960's, and this stimulated demand. Therefore, the initial 1973-74 increase was easily absorbed.

Another reason that demand did not appear to react to the initial price increase was that many energy and oil conservation investments take time to exert a measurable impact. In the industrial, utility and residential/commercial sectors, it may take up to 10 years or more before the majority of the impact from conservation investment is felt.

The time it took to adjust to the price shock was somewhat dependent upon the economic sector. In the electric utility and heavy industry sectors, the total adjustment was slower but still dramatic. In these sectors conservation or fuel switching often requires a substantial capital investment.

On the other hand, adjustment to price changes can be very rapid in the transportation sector of the economy. Much of the conservation is in the form of a change in discretionary driving habits. And there are also fewer substitutes for petroleum products in this sector, and this offsets some of the potential impact from higher prices.

Current dollar prices leveled off after the initial price shock of 1973-74, and the real inflation-adjusted price fell. This muted the conservation adjustment to this price hike.

The 1979-80 price boost produced a much more dramatic adjustment. That price jump coupled with forecasts of future rapidly-rising oil prices led to a sharp drop in oil consumption.

Between 1978 and 1981, the world price of oil jumped another 152%. Responding to this rapid increase in prices, the demand for oil in the non-communist world peaked in 1979 and dropped 12.3% by 1983. Over this four-year period, the worldwide demand response to the price increase was a 0.9% drop in demand for every 10% increase in price. This is relatively inelastic demand. But it did show that there was a demand response to price that must be considered when estimating demand for oil products.

The drop in oil demand as a response to prices, and the worldwide economic slow-down, put downward pressure on crude prices in the early 1980's. A massive crude production capacity surplus developed when demand fell. The surplus led to price competition in the oil market. And the result was a peaking of crude prices in March 1981. Although the official price of the OPEC marker Saudi light crude was boosted to $34/bbl in 1982, actual average transaction prices were falling.

The Saudi light crude marker price was lowered to $29 in early 1983, and again to $28 at the beginning of 1985. This was a 17.6% drop in the official marker crude price. The drop in actual transaction prices was even greater as more and more crude oil trading was based on spot market prices.

The lower crude oil prices had a small positive impact on demand in the non-communist countries. Demand moved up 2.0% in 1984, but slipped 1.1% in 1985.

It should be noted that the strong U.S. dollar at that time relative to other currencies resulted in oil prices being higher outside the U.S.. Export crudes, particularly from OPEC, are denominated in U.S. dollars. In several European countries, oil prices, and therefore petroleum product prices, had actually risen from 1981 to 1985. That tended to suppress demand for petroleum products in Europe and other areas.

Prices were prevented from falling even more rapidly in the 1981-1985 period by the willingness of Saudi Arabia to support prices through a reduction in their production level.

But the most significant recent pricing events occurred in late 1985. First Saudi Arabia became alarmed when their production fell below 2 million b/d, playing the role of swing producer during declining demand for OPEC oil. They were not getting cooperation from other OPEC countries in cutting production to support prices.

So Saudi Arabia abandoned its role of crude exporter of last resort in the fall of 1985 and decided to concentrate on maintaining a "fair share" of the market. They adopted a net-back pricing scheme that enabled them to recapture a substantial share of the export market for crude oil.

OPEC, in December 1985, adopted a similar policy objective of capturing world market share by price competition. These two moves flooded the world market with excess oil, further exaggerating the excess availability problem.

As soon as the winter demand for oil slackened in January 1986, prices began to plummet. The average worldwide price of exported crude fell from $27.10/bbl the first week of January 1986 to $9.35/bbl the first week of August 1986. This was a drop of $17.75/bbl, 65.5% in seven months. This forced OPEC to put together an informal quota agreement effective in September that year. And that helped prices move back up to $13-14/bbl throughout the remainder of 1986. A formal OPEC quota agreement in December helped push average export prices up over $17.50/bbl in 1987. Futures market prices, which are based on one high grade crude, moved over $20/bbl.

As mentioned, oil product demand is relatively price inelastic. But a drop in price of the magnitude that occurred in 1986 is sure to have a stimulative impact on demand and offset some conservation.

As a result, non-communist world demand for petroleum products moved up 3.3% in 1986. Demand in the U.S. moved up 3.5%. Demand in Western Europe moved up 4% in 1986. Even in Japan, where oil conservation is a major economic objective, oil demand moved up 0.9% in 1986.

Prices moved back up in 1987 but were still much lower than in the recent past. And this relatively low price level had a mildly stimulative impact on demand. Total non-communist demand increased 2% in 1987.

Prices slipped again in 1988 due to OPEC over-production. Although OPEC has a quota system in place, a number of the member countries, notably Iraq and the UAE, refused to adhere to the quotas and boosted output. This over-production weakened prices and by October the price dipped close to the low level of 1986.

This did have a tendency to again stimulate demand and non-communist consumption moved up 3.9% in 1988.

Prices in 1989 were very similar to 1987, holding relatively constant as OPEC managed to hold production close to a market clearing level. Prices in 1989 were up about 20% from the year before and this tended to somewhat dampen the increase in petroleum product demand.

There appears to be a price cycle developing that is driven by OPEC production. There is a tendency on the part of the OPEC cartel to over-produce the production quotas they set. There is apparently some tendency for the individual OPEC countries to compete for market share when demand begins to rise. This leads to production well above the quota level set for OPEC.

The excess production puts downward pressure on prices. When prices fall to a level that the OPEC countries feel is unacceptable, a new quota agreement is reached. Some production discipline is practiced for a period of time and prices move back up closer to the OPEC target level.

However, at these relatively low price levels demand continues to move up and market share competition starts up again. And the cycle starts to repeat itself.

OUTLOOK

OPEC continues to be a major factor in determining the outlook for worldwide demand for petroleum products and a major reason why the outlook keeps changing. OPEC's policy is to establish a market clearing production level that will result in a targeted price for their exported crude oil. But OPEC's inability or unwillingness to keep its production in line with the selected quota and product demand is the major reason for the volatility in prices. And price volatility has an impact on product demand. It appears that this problem will plague OPEC and the oil market for the next few years. This will result in average prices lower than anticipated a few years ago. And the lower prices should stimulate product demand.

The level of economic activity will still be the major factor determining the level of energy demand. But the cost of energy is the factor determining the effort given to conservation. And the relative price levels greatly influence the type of energy that will be used to fuel the economic growth. Economic growth, energy demand, oil demand, energy prices, and oil prices are all interrelated and interdependent.

There are still a number of major problems that plague the worldwide economy. The major problems are the huge international debt, large budget deficits, rapid population growth, and unemployment. And there is a growing threat that a wave of protectionism may sweep over the industrialized areas and reduce world trade. Any and all of these could slow worldwide economic growth.

These problems are being contained at the present time. And it is not anticipated that they will cause a recession during the next five years; although it is expected that there will be a slowdown in the rate of growth during the forecast period probably by late 1990 or 1991.

It is expected that worldwide economic activity will grow at an average annual rate of about 3.1% over the five years of the forecast period, 1990–1994.

Relatively low energy prices are expected to be a positive stimulus to economic activity throughout the forecast period. In the early years 1990 and 1991, the lower energy prices will prevent the worldwide economy from slipping into a recession. After the deficit and debt problems are resolved the relatively low real price of oil and energy will help stimulate economic growth of 3 to 4% per year. The establishment of the new economic rules for the European community in 1992 is also expected to boost trade economic activity.

Oil prices have been on an up and down ride over the last several years. Prices plunged in 1986 with the average price dipping below $10/bbl in the summer. A new OPEC accord on production quotas helped prices rebound during the last quarter of 1986. And some production discipline on the part of OPEC resulted in relatively stable prices over $17/bbl for all of 1987. But over-production in 1988 resulted in another slump in prices, falling to close to $10/bbl in October. New production discipline on the part of OPEC and higher than expected demand helped boost prices in 1989 back up to $16-$18/bbl.

Although oil prices rebounded in 1987 and 1989 , they were still well below the high prices of the 1980-1985 period. And these low prices have helped stimulate demand for petroleum products.

As stated in last year's outlook, "oil prices are expected to rebound in 1989, to a level roughly equivalent with 1987", and they did. OPEC was better able to control some of the excess output and lessen the downward pressure on prices. But prices were also propped up by lower than expected non-OPEC production, particularly in the U.S. and U.K.

It now appears that prices will weaken a bit in 1990. Signs of over-production are again breaking out in OPEC. And non-OPEC production is expected to move up in 1990 and steal some of the OPEC share of the market. However, OPEC has learned something from the plunge in prices in 1986 and 1988, so the drop will probably be less severe. The projection is for the average export price to drop to $16.25/bbl in 1990, down only 1%.

The relatively low oil prices and increased economic activity are expected to stimulate product demand. And this in turn will enable a gradual price increase from 1990–1994. For the remainder of the forecast period, 1991–1994, prices are expected to move up about 7.8% per year. This will be slightly faster than the expected inflation rate of 3 to 4% per year. Real prices will however continue to be low enough to stimulate demand.

Looking at the relationship of energy consumption to economic growth, it is expected that energy conservation will continue throughout the forecast period. The growth in energy demand will track the rate of growth of economic activity, but at a slower rate. However, it is expected that the ratio of energy growth to economic growth will be greater than in the recent past.

With low cost energy there is not as much incentive to invest in conservation. Instead, energy will be used more readily to fuel economic growth.

Worldwide energy consumption is expected to increase about 2.2% per year over the 1990-1994 forecast period. This compares to an expected economic growth rate of about 3% per year. The overall increase in energy consumption will be 11.6% over the five year period.

Non-communist world energy demand is projected to increase 10.7% over this period, 2.1% per year. Although investment in conservation will be lower than in past years, it is still expected to continue to move up. There is now a great deal of concern about the impact of energy consumption on the environment. There is greater incentive to increase energy efficiency in the market economies than in the communist world. Demand for energy in the communist sector is expected to move up 13.2% over the forecast period.

Due to the relatively low current and real oil prices and petroleum product prices, the worldwide demand for oil will move up at a rate close to the rate of increase in overall energy demand. Conservation is expected to continue throughout the forecast period, but with lower energy prices the incentive is greatly reduced. Oil will be much more competitive with other fuels and will be able to retain most of its present share of the total energy market.

Demand for all major types of

petroleum products, including fuel oil, is expected to increase over the forecast period. At these lower prices fuel oil will play the role of swing fuel for electric utilities and heavy industry.

Over the five year forecast period 1990-1994, world oil demand is projected to increase 8.5% to 69.7 million b/d in 1994. This is an increase of 5.48 million b/d. Non-communist oil demand is expected to increase 8.5% to 55.26 million b/d in 1993. This will be an increase of 4.32 million b/d, 78.7% of the total increase.

In the non-communist areas, demand for all major products is expected to increase over the forecast period. Low prices and continued economic growth should even boost demand for heavy fuel oil.

Demand for motor gasoline in the non-communist countries is expected to move up 6.6% over the five years to 17.1 million b/d in 1994. The increased vehicle fleet due to population growth and increased affluence is expected to more than offset the increased efficiency of the new vehicles. With low real prices discretionary conservation is also expected to diminish considerably.

Demand for middle distillates is projected to increase 10.6% over the forecast period to 19.8 million b/d in 1994. Middle distillate demand is very closely correlated to increased economic activity.

Fuel oil will be much more competitive with other fuels than in past years of high oil prices. Demand for fuel oil will move up faster than projected if there is any slowing of completion of nuclear facilities, or if coal usage is curtailed due to "acid rain" environmental restraints. These issues are becoming important global issues. Fuel oil consumption is projected to increase 5.2% to 9.6 million b/d in 1994.

Demand for all other oil products is expected to move up 11.3% over the period to 8.8 million b/d in 1994. This includes asphalt for road construction, lubricants and petrochemical feedstocks as well as all other uses for petroleum.

Prices are expected to move up throughout the forecast period, but not to reach the lofty levels that existed prior to the crash in 1986. Current dollar prices are forecast to increase 33.8% over the five year period to $21.95/bbl in 1994.

It is expected that OPEC will not reach total agreement on production quotas and there will not be total adherence to quotas. But there will be sufficient restraint exhibited to firm up prices as demand increases. Prices are expected to fluctuate with seasonal product demand patterns, and prices may be periodically affected by political factors. But it is expected that OPEC will not continuously flood the market with low cost oil. But, instead will accept a gradual increase in price that will come with increased demand, coupled with some OPEC production constraint.

The real price will move up throughout the forecast period since the rate of inflation is projected at only 3-4%. But since the real price will remain well below the pre-1986 levels, it is expected to remain a positive stimulus to economic growth throughout the forecast period.

THE OUTLOOK — WORLDWIDE DEMAND

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
WORLD ENERGY DEMAND (million barrels oil equivalent)									
Non-Communist	39,057	40,014	40,814	41,528	42,594	43,424	44,293	+4,279	+10.7
Communist	20,122	20,524	20,832	21,506	22,142	22,788	23,243	+2,719	+13.2
Total	**59,179**	**60,538**	**61,646**	**63,034**	**64,736**	**66,212**	**67,536**	**+6,998**	**+11.6**
WORLD OIL DEMAND (thousand barrels/day)									
Non-Communist	49,765	50,939	51,805	52,531	53,634	54,438	55,255	+4,316	+ 8.5
Communist	13,480	13,310	13,535	13,750	14,039	14,263	14,477	+1,167	+ 8.8
Total	**63,245**	**64,249**	**65,340**	**66,281**	**67,673**	**68,701**	**69,732**	**+5,483**	**+ 8.5**
PETROLEUM PRODUCT DEMAND (thousand barrels/day)									
Non-Communist areas									
Gasolines	15,767	16,013	16,251	16,453	16,683	16,873	17,065	+1,052	+ 6.6
Middle distillates	17,603	17,880	18,145	18,372	18,918	19,344	19,780	+1,900	+10.6
Fuel oil	9,029	9,171	9,303	9,405	9,508	9,576	9,645	+ 474	+ 5.2
Other products	7,366	7,875	8,106	8,301	8,525	8,645	8,765	+ 890	+11.3
Total	**49,765**	**50,939**	**51,805**	**52,531**	**53,634**	**54,438**	**55,255**	**+4,316**	**+ 8.5**
Crude oil price Average world export price ($/barrel)	13.79	16.40	16.25	17.25	19.25	20.85	21.95	+ 5.55	+33.8

WORLDWIDE DEMAND— KEYS TO THE FUTURE

1. No recession is expected during the forecast period 1990–1994, but a slowdown in the growth rate is expected in late 1990 or 1991. Then Europe in 1992 is expected to give the worldwide economy a boost that should last through 1994. Worldwide economic growth is projected at an average rate of 3%/year over the forecast period. Major problems with international debt, large budget deficits, unemployment, etc., will be contained. Population and environmental problems are expected to grow in importance.

2. OPEC will continue to have problems with controlling the overall production level and this will put some downward pressure on prices throughout the forecast period. However, it is expected that they will exhibit sufficient restraint from time to time to prevent a price collapse. It is expected that prices will move up gradually along with increased demand for petroleum products. Prices are expected to move up 33.8% to $21.95/bbl by 1994.

3. The relatively low oil and energy prices are expected to dampen the incentive for investing in energy conservation. There will be continued improvement in energy consumption efficiency, but the rate of improvement will be slower.

4. The increased level of economic activity and relatively low oil prices will help stimulate demand for petroleum products. World demand for petroleum products is expected to increase at a rate of 1.6%/year over the forecast period.

5. Demand for distillate and other special products will lead the way in the growth in product demand. But lower prices will also stimulate demand for gasoline and heavy fuel oil.

WORLDWIDE OUTLOOK—SUPPLY

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Control over the supply side of the world petroleum market is slipping more and more into the hands of OPEC. Non-OPEC production appears close to peaking. And even if there is potential for some growth in non-OPEC production, it does not appear that it will keep pace with the growth in demand. Therefore, OPEC will increase market share along with an increase in overall demand for crude oil.

In the future, events associated with OPEC and its member countries will continue to have the major influence on current activity and the outlook for the worldwide oil industry.

The level of production emanating from the OPEC group of countries is now, and will be in the future, determining the level of crude oil prices, the level of investment and the level and type of activity throughout the worldwide oil industry.

It was felt that the OPEC countries had learned a profitable lesson in 1986 when excess production drove prices down to an unacceptable low level. It was felt that following the price crash and loss of revenue, it would be known that some level of cooperation and restraint would be essential to optimize income from the current market.

But individual internal political or economic considerations often outweigh the need to cooperate within OPEC. And a degree of distrust between OPEC members is also driving the tendency to compete for market share and toward excess production.

The shift in OPEC policy in 1986, from one concentrating on supporting price to a policy of gaining production market share, led to a sudden and precipitous drop in prices. That 1986 policy flooded the market with inexpensive crude and allowed prices to free fall. And it led to export crude prices lower than anyone would have dreamed of forecasting a few years earlier.

At that time it was Saudi Arabia's abandonment of the sale of swing producer that eventually led to the OPEC experiment with disaster.

Having acquired some newly discovered economic wisdom from this market experiment, OPEC reestablished a quota system in the latter part of 1986. First they adopted an emergency temporary set of quotas in September 1986. They then adopted a formal quota agreement that tightened up supply and boosted prices in 1987.

But the lesson was not completely learned and again in 1988 excess production drove down prices. Iraq decided not to cooperate with OPEC and adhere to the quota, primarily due to its dispute with Iran and the additional capacity that was developed to help finance the war. In addition, the UAE adopted an independent course that led to substantial overproduction.

Saudi Arabia did not come to the rescue by slashing production to prop up prices as they had done in earlier years. Instead the market was flooded with oil from OPEC countries competing for market share.

That sequence of events was an important turning point for the oil market. After that OPEC was forced to pay more attention to market forces. And it became evident that the only way they could achieve the targeted price was to adhere to some production quota. This has led to the volatile swings in crude prices over the past four years, as OPEC and member countries test the market.

Probably one of the major reasons that the Saudis did not make a major effort to prop up the price is that lower prices are in their long run best interests. The Saudis prefer a price that will stimulate long term steady growth in oil demand. And there are a number of other OPEC members with large reserves that prefer this price policy to maximizing present income.

REVIEW

PRODUCTION. Worldwide economic activity expanded substantially and with little interruption throughout the 1950's, 1960's and into the 1970's. A substantial proportion of the economic activity and growth was fueled by crude oil. Worldwide production of crude oil expanded steadily throughout this period to meet the ever-increasing demand. New field development and capacity additions were sustained at a pace close to that of the demand for oil, which in turn tracked the economic growth rate.

But two price hikes, the first in 1973–1974 and the second in 1979–1981, put an end to this steady climb in crude production. With worldwide economic growth fueled by oil consumption, the first price hike only slowed consumption. But it did give rise to more serious thought about and investment in energy conservation.

The second, and larger, price hike stopped the growth in oil consumption and production in its tracks. The second major price increase occurred in the 1979–1981 period. It was the major reason for the subsequent decrease in consumption and production of oil. Not only were steps taken to conserve energy and to reduce energy costs, but these adjustments led to a slow-down in economic activity. And this contributed further to the drop in demand for oil.

Total world hydrocarbon liquids production (crude oil, condensate and natural gas liquids) peaked in 1979 at 65.775 million barrels per day. Production in the non-communist world also peaked in 1979 at 51.28 million barrels per day. The increased cost of oil forced conservation, and world production fell for four consecutive years, 1979–1983, dropping to 56.685 million b/d in 1983. This was a drop in production of 9.09 million b/d, or 13.8%.

Non-communist production, which is more sensitive to market forces, fell 9.74 million b/d (19%) to 41.54 million b/d. Communist area production actually continued to rise over this period, increasing from 14.495 million b/d in 1979 to 15.145 million b/d in 1983.

The drop in world crude production mirrored the drop in demand for petroleum products. The latter was a direct result of the sharp increase in the price of oil products, resulting from the OPEC crude price increases. In addition, there was a rapid shift to other

WORLDWIDE OIL RESERVES

							Jan. 1								
	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	Change 1989-1979	% change 1989/1979
							(1,000 bbl)								
Australia	1,380,000	2,000,000	2,100,000	2,130,000	2,360,000	1,709,000	1,622,077	1,586,000	1,430,900	1,449,000	1,712,800	1,691,960	1,673,089	−426,911	−20.3
Brunei	1,625,000	1,550,000	1,480,000	1,800,000	1,710,000	1,630,000	1,240,000	1,390,000	1,400,000	1,480,000	1,420,900	1,420,000	1,400,000	−80,000	−5.4
India	3,000,000	3,000,000	2,900,000	2,600,000	1,710,000	2,672,000	3,416,400	3,485,000	3,500,000	3,736,000	4,202,800	4,250,000	6,354,200	+3,454,200	+119.1
Indonesia	10,500,000	10,000,000	10,200,000	9,600,000	9,500,000	9,800,000	9,550,000	9,100,000	8,650,000	8,500,000	8,300,000	8,400,000	8,250,000	−1,950,000	−19.1
Malaysia	2,430,000	2,500,000	2,800,000	2,800,000	3,000,000	2,800,000	3,325,000	3,000,000	3,000,000	3,100,000	2,820,500	2,900,000	2,922,000	+122,000	+4.4
Others	456,140	699,270	527,200	425,200	480,500	541,800	602,600	408,400	549,000	591,300	566,500	691,690	768,088	+240,888	+45.7
Total Asia-Pacific	**19,391,140**	**19,479,270**	**20,007,200**	**19,355,200**	**19,630,500**	**19,150,800**	**19,756,077**	**18,969,400**	**18,529,900**	**18,856,300**	**19,023,500**	**19,353,650**	**21,367,377**	**+1,360,177**	**+6.8**
Norway	5,660,000	6,000,000	5,900,000	5,750,000	5,500,000	7,620,000	6,800,000	7,660,000	8,300,000	10,900,000	10,500,000	14,800,000	10,435,000	+4,535,000	+76.9
United Kingdom	16,800,000	19,000,000	16,000,000	15,400,000	14,800,000	14,800,000	13,900,000	13,150,000	13,590,000	13,000,000	9,000,000	5,200,000	5,175,000	−10,825,000	−67.7
Others	2,078,810	1,862,500	2,066,000	2,626,400	2,785,000	2,214,500	2,223,680	2,209,480	2,535,500	2,512,600	2,438,050	2,447,820	2,946,575	+880,575	+42.6
Total Western Europe	**24,538,810**	**26,862,500**	**23,966,000**	**23,776,400**	**23,085,000**	**24,634,500**	**22,923,680**	**23,019,480**	**24,425,500**	**26,412,600**	**21,938,050**	**22,447,820**	**18,556,575**	**−5,409,425**	**−22.6**
Abu Dhabi	29,000,000	31,000,000	30,000,000	28,000,000	29,000,000	30,600,000	30,510,000	30,400,000	30,500,000	31,000,000	31,000,000	92,205,000	92,205,000	+62,205,000	+207.4
Divided Zone	6,300,000	6,200,000	6,480,000	6,260,000	6,060,000	6,500,000	5,840,000	5,695,000	5,420,000	5,380,000	5,212,100	5,210,000	5,120,000	−1,270,000	−19.6
Dubai	1,500,000	1,400,000	1,300,000	1,400,000	1,400,000	1,270,000	1,440,000	1,440,000	1,440,000	1,400,000	1,350,000	4,000,000	4,000,000	+2,700,000	+207.7
Iran	63,000,000	62,000,000	59,000,000	58,000,000	57,500,000	57,000,000	55,308,000	51,000,000	48,500,000	47,876,000	48,800,000	92,850,000	92,850,000	+33,850,000	+57.4
Iraq	34,000,000	34,500,000	32,100,000	31,000,000	30,000,000	29,700,000	41,000,000	43,000,000	44,500,000	44,110,000	47,100,000	100,000,000	100,000,000	+67,900,000	+211.5
Kuwait	67,400,000	67,000,000	66,200,000	65,400,000	64,900,000	64,480,000	64,230,000	63,900,000	90,000,000	89,774,000	91,916,000	91,920,000	91,920,000	+25,720,000	+38.9
Oman	5,800,000	5,650,000	2,500,000	2,400,000	2,340,000	2,570,000	2,730,000	2,790,000	3,500,000	4,000,000	4,032,000	4,012,000	4,071,160	+1,571,160	+62.8
Qatar	5,700,000	5,600,000	4,000,000	3,760,000	3,585,000	3,434,000	3,425,000	3,330,000	3,350,000	3,300,000	3,154,000	3,150,000	3,150,000	−850,000	−21.3
Saudi Arabia	151,400,000	150,000,000	165,700,000	163,350,000	165,000,000	164,600,000	162,400,000	166,000,000	169,000,000	168,800,000	166,573,900	166,980,000	169,970,000	+4,270,000	+2.6
Syria	2,200,000	2,150,000	2,080,000	2,000,000	1,940,000	1,890,000	1,521,000	1,490,000	1,450,000	1,440,000	1,400,000	1,750,000	1,730,000	−350,000	−16.8
Others	1,380,000	666,000	636,000	377,300	346,000	795,950	881,893	1,055,800	720,750	945,710	1,340,700	2,603,250	6,412,619	+5,776,619	+908.3
Total Middle East	**367,680,000**	**366,166,000**	**369,996,000**	**361,947,300**	**362,071,000**	**362,839,950**	**369,285,893**	**370,100,800**	**398,380,750**	**398,025,710**	**401,878,700**	**564,680,250**	**571,516,779**	**+201,522,779**	**+54.5**
Algeria	6,800,000	6,600,000	6,300,000	8,440,000	8,200,000	8,080,000	9,440,000	9,220,000	9,000,000	8,820,000	8,800,000	8,500,000	8,400,000	+2,100,000	+33.3
Angola-Cabinda	1,210,000	1,160,000	1,115,000	1,200,000	1,200,000	1,450,000	1,635,000	1,700,000	1,800,000	2,000,000	1,149,400	1,149,000	2,024,000	+909,000	+81.5
Congo Republic	285,000	360,000	315,000	400,000	660,000	1,300,000	1,550,000	400,000	480,000	650,000	720,000	720,000	710,000	+395,000	+125.4
Egypt	1,950,000	2,450,000	3,200,000	3,100,000	2,900,000	2,930,000	3,325,000	3,450,000	3,200,000	3,850,000	3,600,000	4,300,000	4,300,000	+1,100,000	+34.4
Libya	25,500,000	25,000,000	24,300,000	23,500,000	23,000,000	22,600,000	21,500,000	21,270,000	21,100,000	21,300,000	21,300,000	21,000,000	22,000,000	−2,300,000	−9.5
Nigeria	19,500,000	18,700,000	18,200,000	17,400,000	16,700,000	16,500,000	16,750,000	16,550,000	16,650,000	16,600,000	16,000,000	15,980,000	16,000,000	−2,200,000	−12.1
Tunisia	2,700,000	2,670,000	2,300,000	2,250,000	1,652,000	1,690,000	1,860,000	1,820,000	1,514,000	1,800,000	1,800,000	1,800,000	1,790,000	−510,000	−22.2
Others	2,625,200	2,260,150	2,162,125	782,100	836,375	1,621,630	1,761,690	2,497,020	1,796,550	1,714,050	1,824,650	1,800,700	1,739,770	−422,355	−19.5
Total Africa	**60,570,200**	**59,200,150**	**57,892,125**	**57,072,100**	**55,148,375**	**56,171,630**	**57,821,690**	**56,907,020**	**55,540,550**	**56,734,050**	**55,194,050**	**55,249,700**	**56,963,770**	**−928,355**	**−1.6**
Argentina	2,300,000	2,503,000	2,400,000	2,400,000	2,457,000	2,650,000	2,590,000	2,428,700	2,266,000	2,300,000	2,270,000	2,270,000	2,268,000	−132,000	−5.5
Brazil	800,000	880,000	1,200,000	1,220,000	1,300,000	1,325,060	1,750,000	1,800,000	1,976,000	2,070,000	2,250,000	2,340,000	2,550,000	+1,350,000	+112.5
Ecuador	1,700,000	1,640,000	1,170,000	1,100,000	1,100,000	850,000	1,400,000	1,675,000	1,400,000	1,650,000	1,672,300	1,615,000	1,350,000	+180,000	+15.4
Mexico	7,000,000	14,000,000	16,000,000	31,250,000	44,000,000	56,990,000	48,300,000	48,000,000	48,600,000	49,300,000	54,653,000	48,610,000	54,110,000	+38,110,000	+238.2
Venezuela	15,270,000	18,200,000	18,000,000	17,870,000	17,950,000	20,300,000	21,500,000	24,850,000	25,845,000	25,591,000	25,000,000	56,300,000	58,083,900	+40,083,900	+222.7
United States	31,300,000	29,500,000	28,500,000	26,500,000	26,400,000	29,785,000	29,785,000	27,300,000	27,300,000	28,000,000	24,560,000	25,270,000	26,500,000	−2,000,000	−7.0
Canada	6,200,000	6,000,000	6,000,000	6,800,000	6,400,000	7,300,000	7,020,000	6,730,000	7,075,000	6,500,000	6,850,000	6,825,000	6,785,514	+785,514	+13.1
Others	2,538,950	3,147,000	2,476,500	2,632,500	2,682,837	2,867,210	2,942,066	2,922,200	3,228,700	3,331,400	2,870,000	3,186,980	3,588,836	+1,112,336	+44.9
Total Western Hemisphere	**67,108,950**	**75,870,000**	**75,746,500**	**89,772,500**	**102,289,837**	**122,067,270**	**115,287,066**	**115,705,900**	**117,690,700**	**118,742,400**	**120,125,300**	**146,416,980**	**155,236,250**	**+79,489,750**	**+104.9**
Total Non-Communist	**539,290,000**	**547,847,920**	**547,607,825**	**551,623,500**	**562,224,712**	**584,864,150**	**585,074,406**	**584,782,600**	**614,567,400**	**618,771,060**	**618,199,600**	**808,148,400**	**823,642,751**	**+276,034,926**	**+50.4**
China	20,000,000	20,000,000	20,000,000	20,000,000	20,500,000	19,895,000	19,485,000	19,100,000	19,100,000	18,420,000	18,400,000	18,400,000	23,550,000	+3,550,000	+17.8
U.S.S.R.	78,100,000	75,000,000	71,000,000	67,000,000	63,000,000	63,000,000	63,000,000	63,000,000	63,000,000	61,000,000	59,000,000	59,000,000	58,500,000	−12,500,000	−17.6
Others	3,000,000	3,000,000	3,000,000	3,000,000	2,800,000	2,950,000	2,630,000	2,500,000	2,000,000	1,950,000	1,850,000	1,800,000	1,750,000	−1,250,000	−41.7
Total Communist	**101,100,000**	**98,000,000**	**94,000,000**	**90,000,000**	**86,300,000**	**85,845,000**	**85,115,000**	**84,600,000**	**84,100,000**	**81,370,000**	**79,250,000**	**79,200,000**	**83,800,000**	**−10,200,000**	**−10.9**
Total World	**640,390,000**	**645,847,920**	**641,607,825**	**641,623,500**	**648,524,712**	**670,709,150**	**670,189,406**	**669,302,600**	**698,667,400**	**700,141,060**	**697,449,600**	**887,348,400**	**907,442,751**	**−265,834,926**	**−41.4**
Total OPEC	**440,685,000**	**440,185,000**	**445,186,000**	**435,831,300**	**434,580,000**	**436,709,000**	**436,858,000**	**448,420,000**	**476,415,000**	**475,211,000**	**477,523,300**	**670,655,000**	**676,008,900**	**+230,822,900**	**+51.8**
OPEC as % of world	68.9%	68.2%	69.4%	68.0%	67.1%	65.2%	65.2%	67.0%	68.2%	67.9%	68.5%	75.6%	74.5%	—	—

Source: Oil & Gas Journal

energy sources for fueling economic growth. Although the costs of other energy forms were also on the rise, they were not increasing as rapidly as the cost of oil. Oil led the way and became the highest-cost energy form for many activities.

With declining demand for crude oil products and therefore for crude production, prices began to slide in the last half of 1981. With weak demand relative to supply prices slid downward gradually throughout the 1981–1985 period.

The downward pressure on prices from the excess capacity and the excess production intensified in 1986 and prices plummeted sharply. Tighter supply due to some OPEC production discipline led to a slight rebound in 1987. Excess OPEC production put downward pressure on prices again in 1988. Prices weakened and fell although they did not fall as sharply or as far as in 1986. 1989 was a repeat of 1987 with a rebound in prices followed by relative price stability. A sharp drop in U.S. and U.K. production coupled with some OPEC production discipline stabilized the market.

The lower prices slowed conservation efforts and slightly stimulated demand over the 1981–1985 period. There was also a slight rebound in production in 1984, both total world and non-communist. Non-communist production increased 1.33 million b/d, 3.2%, to 42.87 million b/d. Total world output increased 1.41 million b/d, up 2.5% to 58.1 million b/d. Lower crude oil prices and increased economic growth and increased oil product demand were the major reasons for this increase in production. Following this, production slipped slightly in 1985. Total non-communist production dropped 0.9% to 42.47 million b/d. Total world output fell to 57.6 million b/d.

However, this was reversed again when the slump in prices in 1986 kicked off a surge in demand for oil. Non-communist output jumped up 2.2 million b/d to 44.7 million b/d, and total world output was up 2.7 million b/d at 60.3 million b/d, the highest level since 1980.

Due to higher prices output slipped slightly in 1987, falling 125,000 b/d. The drop was all in the non-communist output which dipped 345,000 b/d. Lower crude prices in 1988 again reversed the direction and output moved up over 2 million b/d. Non-communist output jumped up 5.4% to 46.32 million b/d, and total world production was up 4% at 62.2 million b/d. Prices were relatively stable throughout most of 1989 but low enough to stimulate demand. Non-communist production moved up another 2 million b/d on the strength of the strong economic growth and product demand. Communist production dipped slightly due to internal problems in the U.S.S.R.

The level of output or demand for crude oil is quite obviously very sensitive to the price of crude oil and is being dampened or stimulated by the volatile price movements.

OPEC PRODUCTION AND CAPACITY. The initial drop in prices in 1981-1983 was mainly due to the development of a massive excess crude oil production capacity worldwide. With the vast majority of the excess capacity in the OPEC countries. Both increased output in non-OPEC countries and the drop in demand contributed to the development of an excess capacity problem in the oil industry. In fact, the real key to understanding the world oil supply situation and crude oil price developments is understanding the worldwide crude production capacity situation.

Throughout the 1950's, 1960's and into the 1970's, as more and more oil was required to fuel worldwide economic growth, production capacity was expanded to meet the demand. Production facilities were installed to allow a buffer for maintenance and other non-routine contingencies. Generally, development plans called for output to average about 92% of installed capacity. This allowed for some excess capacity for maintenance downtime and other contingencies.

The international oil companies, as a rule, obtained concessions and developed the lower-cost areas first. These were mainly the prolific fields of the now OPEC countries. Capacity seldom exceeded demand by a large amount because the rate of installation of new capacity was regulated to meet demand growth.

As demand for oil increased throughout the 1960's and into the 1970's, it was increased production from the OPEC countries that filled the need. By 1976, OPEC output represented 51.8% of total worldwide output, and 65.6% of non-communist world production.

OPEC production actually peaked in 1977 at 31.68 million b/d, 50.6% of worldwide production, and 64.5% of non-communist production. OPEC output remained above 30 million b/d in

WORLDWIDE OIL PRODUCTION*

Country/Area	1978	1979	1980	1981	1982	1983 (1,000 b/d)	1984	1985	1986	1987	1988	% change 88/78	% change 88/79
NORTH AMERICA													
U.S.	10,275	10,135	10,170	10,180	10,200	10,245	10,505	10,545	10,230	9,945	9,750	−5.1	−3.8
Canada	1,575	1,770	1,725	1,545	1,485	1,515	1,645	1,815	1,840	1,695	1,775	12.7	0.8
Total North America	**11,850**	**11,905**	**11,895**	**11,725**	**11,685**	**11,760**	**12,150**	**12,360**	**12,070**	**11,640**	**11,525**	**−2.7**	**−3.2**
LATIN AMERICA													
Argentina	455	470	490	490	490	475	465	460	430	430	445	−2.2	−5.3
Brazil	165	170	195	220	275	365	460	585	595	600	605	266.7	255.9
Colombia	130	150	125	135	145	155	170	175	300	385	375	188.5	150.0
Ecuador	205	215	205	210	200	240	255	275	280	165	300	46.3	39.5
Mexico	1,330	1,630	2,155	2,585	3,005	2,950	3,015	3,015	2,750	2,875	2,855	114.7	75.2
Trinidad	230	215	210	200	175	165	170	175	165	165	1,500	552.2	597.7
Venezuela	2,235	2,425	2,235	2,180	1,965	1,875	1,875	1,730	1,845	1,775	1,925	−13.9	−20.6
Others	215	255	280	275	295	260	270	270	250	235	205	−4.7	−19.6
Total Latin America	**4,965**	**5,530**	**5,895**	**6,295**	**6.550**	**6,485**	**6,680**	**6,685**	**6,615**	**6,630**	**6,860**	**38.2**	**24.1**
WESTERN EUROPE													
Austria	35	35	30	25	25	25	25	25	20	20	20	−42.9	−42.9
Denmark	10	10	5	15	35	45	45	60	75	95	95	850.0	850.0
France	20	25	30	35	50	50	60	70	75	75	75	275.0	200.0
Italy	25	30	35	25	30	40	40	45	50	70	90	260.0	200.0
Norway	350	385	525	505	530	660	755	835	910	1,000	1,150	228.6	198.7
Turkey	55	55	45	45	45	45	40	40	45	50	50	−9.1	−9.1
United Kingdom	1,095	1,600	1,650	1,835	2,125	2,360	2,580	2,655	2,665	2,555	2,360	115.5	47.5
West Germany	100	95	90	90	85	80	80	80	80	75	75	−25.0	−21.1
Others	45	60	65	60	95	145	140	150	155	15	135	200.0	125.0
Total Western Europe	**1,735**	**2,295**	**2,475**	**2,635**	**3,020**	**3,450**	**3,765**	**3,960**	**4,075**	**4,090**	**4,050**	**133.4**	**76.5**
MIDDLE EAST													
Abu Dhabi	1,450	1,465	1,345	1,135	885	830	825	890	1,090	1,245	1,330	−8.3	−9.2
Dubai	360	355	350	360	360	345	375	390	390	405	400	11.1	12.7
Iran	5,275	3,175	1,480	1,325	2,410	2,465	2,195	2,215	1,905	2,310	2,275	−56.9	−28.3
Iraq	2,560	3,475	2,645	895	1,010	1,105	1,225	1,440	1,745	2,090	2,600	1.6	−25.2
Kuwait	1,945	2,270	1,430	965	705	900	985	920	1,250	1,075	1,340	−31.1	−41.0
Neutral Zone	470	570	545	375	315	310	405	340	345	390	320	−31.9	−43.9
Oman	315	295	285	325	325	390	420	505	560	580	605	92.1	105.1
Qatar	485	510	460	425	340	310	425	340	355	340	360	−25.8	−29.4
Saudi Arabia	8,315	9,555	9,990	9,985	6,695	5,225	4,760	3,565	5,150	4,360	6,255	−36.8	−45.0
Others	250	240	225	225	230	230	240	295	315	355	580	132.0	141.7
Total Middle East	**21,425**	**21,910**	**18,755**	**16,015**	**13,275**	**12,110**	**11,855**	**10,900**	**13,105**	**13,150**	**15,065**	**−29.7**	**−31.2**
AFRICA													
Algeria	1,230	1,255	1,120	1,035	1,045	980	1,075	970	1,060	1,040	1,070	−13.0	−14.7
Angola	130	150	150	140	120	160	185	230	280	350	450	246.2	200.0
Egypt	480	525	590	690	705	725	860	905	835	915	885	84.4	68.6
Gabon	210	205	175	150	155	155	150	155	160	155	170	−19.0	−17.1
Libya	1 985	2,090	1,830	1,220	1,135	1,110	1,105	1,105	1,045	1,000	1,055	−46.9	−49.5
Nigeria	1,895	2,300	2,055	1,440	1,285	1,235	1,385	1,475	1,465	1,290	1,365	−28.0	−40.7
Other Africa	170	225	260	305	340	380	440	450	465	445	465	173.5	106.7
Total Africa	**6,100**	**6,750**	**6,180**	**4,980**	**4,785**	**4,745**	**5,200**	**5,290**	**5,310**	**5,205**	**5,460**	**−10.5**	**−19.1**
ASIA AND AUSTRALASIA													
Japan	10	10	10	10	10	10	10	10	15	10	15	50.0	50.0
Brunei	205	240	235	175	165	175	160	150	165	140	140	−31.7	−41.7
India	225	260	190	300	400	505	560	605	625	610	635	182.2	144.2
Indonesia	1,635	1,590	1,575	1,680	1,415	1,345	1,410	1,335	1,400	1,320	1,315	−19.6	−17.3
Malaysia	215	285	275	250	295	420	440	435	540	505	545	153.5	91.2
Other Asia	40	50	60	50	55	70	85	100	115	105	110	175.0	120.0
Australasia†	450	455	400	410	420	470	550	635	610	620	600	33.3	31.9
Total Asia & Australasia	**2,780**	**2,890**	**2,745**	**2,875**	**2,760**	**2,995**	**3,215**	**3,270**	**3,470**	**3,310**	**3,360**	**20.9**	**16.3**
Total NCW	**48,855**	**51,280**	**47,945**	**44,525**	**42,075**	**41,545**	**42,865**	**42,465**	**44,645**	**44,025**	**46,320**	**−5.2**	**−9.7**
COMMUNIST													
China	2,090	2,130	2,125	2,035	2,050	2,135	2,300	2,515	2,630	2,675	2,735	30.9	28.4
U.S.S.R.	11,595	11,870	12,215	12,370	12,430	12,520	12,450	12,150	12,560	12,745	12,705	9.6	7.0
Others	515	495	470	445	505	490	485	465	470	450	435	−15.5	−12.1
Total Communist	**14,200**	**14,495**	**14,810**	**14,850**	**14,985**	**15,145**	**15,235**	**15,130**	**15,660**	**15,870**	**15,875**	**11.8**	**9.5**
Total World	**63,055**	**65,775**	**62,755**	**59,375**	**57,060**	**56,690**	**58,100**	**57,595**	**60,305**	**59,895**	**62,195**	**−1.4**	**−5.4**
OPEC	30,280	31,465	27,445	23,380	19,930	18,425	18,470	17,215	19,555	19,030	21,145	−30.2	−32.8

*Includes natural gas liquids

†Includes Australia and New Zealand.

Source: British Petroleum

1978 and 1979, with 1979 at 31.47 million b/d. That was 47.8% of total world demand and 61.4% of non-communist demand for that year.

OPEC was beginning to lose a part of its market share because the rapid rise in prices had stimulated the development of crude production in non-OPEC countries, and non-OPEC output was beginning to supply a greater proportion of demand.

In the late 1960's and early 1970's, as worldwide demand was on the rise, the OPEC countries gained control of their own oil resources, taking control from the international oil companies. And they subsequently changed the approach to supplying worldwide oil demand that had been followed by the international oil companies.

The international companies had been efficient at exploration and production. The price was kept low by continuous development of additional oil resources in the face of rising demand.

Oil resources were abundant in many of the OPEC countries, and the international oil companies managed to increase capacity in step with demand. This also kept prices low. And the low prices encouraged increased consumption.

The OPEC countries had contended for some time that their oil resources were worth more than the revenues received. When they took control they changed course and raised prices. They took advantage of the worldwide dependence on oil and the worldwide economic expansion that was being fueled by oil. They chose to test the demand response to higher prices (elasticity of demand), and raised prices sharply in 1973–1974. Even in the face of a sharp price hike demand continued to rise. So they boosted prices again in 1979–1981.

These price hikes had a dramatic impact on the production capacity situation worldwide, but particularly in the OPEC countries.

Through the 1960's and up until 1973, excess capacity in the worldwide oil industry was 7–8%. Excess capacity was about 7% of total capacity and 8% of production. After the initial price hike, excess

WORLDWIDE NATURAL GAS PRODUCTION

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	% change 88/78
	(Billion cu ft)											
NORTH AMERICA												
U.S.	19,122	19,663	19,404	19,181	17,758	16,033	17,393	16,366	15,978	16,535	16,687	−12.7
Canada	2,744	2,944	2,709	2,642	2,607	2,454	2,524	2,701	2,521	2,771	3,163	15.3
Total North America	**21,866**	**22,607**	**22,113**	**21,823**	**20,365**	**18,487**	**19,917**	**19,067**	**18,499**	**19,306**	**19,850**	**−9.2**
LATIN AMERICA												
Argentina	274	255	278	294	341	365	474	498	662	659	757	176.3
Bolivia	67	78	82	98	102	98	90	90	102	102	110	64.2
Chile	125	122	98	82	110	106	102	94	153	153	153	22.4
Mexico	862	917	1,066	1,227	1,282	1,231	1,035	953	953	976	1,102	27.8
Trinidad	74	114	86	86	86	106	122	114	125	137	157	112.2
Venezuela	521	576	588	588	600	553	612	608	615	678	721	38.4
Others	153	172	184	180	200	259	294	318	318	318	372	143.1
Total Latin America	**2,076**	**2,234**	**2,382**	**2,555**	**2,721**	**2,718**	**2,729**	**2,675**	**2,928**	**3,023**	**3,372**	**62.4**
WESTERN EUROPE												
France	286	282	274	259	243	216	208	176	137	125	102	−64.3
Italy	486	474	404	455	498	435	459	486	564	576	576	18.5
Netherlands	2,630	2,775	2,701	2,650	2,285	2,395	2,411	2,524	2,203	2,199	1,870	−28.9
Norway	525	760	925	921	898	898	972	894	953	1,047	1,051	100.2
United Kingdom	1,321	1,341	1,254	1,250	1,196	1,200	1,305	1,454	1,529	1,599	1,560	18.1
West Germany	604	604	553	564	494	514	537	478	537	592	537	−11.1
Others	87	87	87	87	87	87	87	87	87	87	87	—
Total Western Europe	**5,939**	**6,323**	**6,198**	**6,186**	**5,701**	**5,745**	**5,979**	**6,099**	**6,010**	**6,225**	**5,783**	**−2.6**
MIDDLE EAST												
Abu Dhabi	176	220	204	212	216	220	227	231	251	267	302	71.6
Iran	686	706	294	255	255	388	478	514	537	670	619	− 9.8
Kuwait	220	306	243	188	145	169	172	180	145	157	176	−20.0
Saudi Arabia	333	412	517	898	372	329	459	478	533	741	896	169.7
Others	247	380	388	329	365	325	404	439	443	498	564	128.3
Total Middle East	**1,862**	**2,024**	**1,646**	**1,882**	**1,353**	**1,431**	**1,740**	**1,842**	**1,909**	**2,333**	**2,559**	**54.0**
AFRICA												
Algeria	490	917	757	866	941	1,258	1,192	1,317	1,239	1,470	1,541	214.5
Libya	180	239	184	141	118	129	161	184	223	235	200	11.1
Nigeria	12	47	39	63	43	51	59	51	43	39	98	716.7
Others	47	63	71	71	110	125	165	223	235	255	247	425.5
Total Africa	**729**	**1,266**	**1,051**	**1,141**	**1,212**	**1,563**	**1,577**	**1,775**	**1,740**	**1,999**	**2,086**	**186.1**
ASIA AND AUSTRALASIA												
Japan	94	86	78	74	71	74	74	78	74	78	74	−21.3
Indonesia	384	557	655	678	694	780	1,027	1,070	1,113	1,149	1,223	218.5
Other Southeast Asia	306	314	318	329	372	447	678	839	949	1,062	1,098	258.8
Pakistan	208	200	243	239	310	337	357	365	388	419	443	113.0
Other South Asia	204	196	220	259	361	404	494	506	529	635	706	246.1
Australasia*	349	384	427	466	494	533	545	600	682	678	706	102.3
Total Asia and Australasia	**1,545**	**1,737**	**1,941**	**2,045**	**2,302**	**2,575**	**3,175**	**3,458**	**3,735**	**4,021**	**4,250**	**175.1**
Total Non-Communist World	**33,817**	**36,191**	**35,331**	**35,632**	**33,654**	**32,519**	**35,117**	**34,916**	**34,821**	**36,907**	**37,900**	**12.1**
COMMUNIST												
China	486	490	478	455	392	423	427	451	463	490	494	1.6
USSR	12,713	13,861	14,904	16,143	17,691	18,910	20,713	22,685	24,202	25,602	27,193	113.9
Others	2,148	2,042	2,007	2,101	2,113	2,183	2,313	2,328	2,313	2,387	2,450	14.1
Total Communist	**15,347**	**16,393**	**17,389**	**18,699**	**20,196**	**21,516**	**23,453**	**25,464**	**26,978**	**28,479**	**30,137**	**96.4**
Total World	**49,164**	**52,584**	**52,720**	**54,331**	**53,850**	**54,035**	**58,570**	**60,380**	**61,799**	**65,386**	**68,037**	**38.4**

*Includes Australia and New Zealand.

Source: British Petroleum

capacity began to increase, moving up to 10–12% in 1974 and as high as 19–25% in 1975. This was 19% of available capacity and 25% of actual production. The Iranian revolution in 1978–1979 took some Iranian capacity out of service and helped reduce excess capacity to the 9–10% level. This allowed OPEC to push through the massive 1979–1980 price increase.

However, following 1979 the combination of declining demand and rising non-OPEC production resulted in the development of massive excess capacity. Most OPEC capacity had been put in place by 1977, but non-OPEC production was stimulated by the increase in prices, and new capacity was added continuously. Only the Iranian revolution and the Iran-Iraq war kept the excess capacity situation somewhat in check. But by 1983 excess capacity was 15.6 million b/d, which was 29% of total capacity and 41% of total production/demand. This started to put substantial downward pressure on prices.

Excess capacity dropped only marginally in 1984 to 15.3 million b/d. This was still 28% of total available non-communist capacity and 39% of total production. In 1985, excess capacity moved up again to 15.6 million b/d. This represented 29% of total non-communist oil production capacity, and about 40% of total oil production. In 1986 the excess capacity fell slightly to 14 million b/d. This was 26% of total capacity and 35% of total production. In 1987 there was little change in these numbers. And the excess capacity continued to exert downward pressure on prices.

WORLD CRUDE OIL PRICES

Official Sales and Term Contracts
(Dollars per barrel)
(1 January)

Year	Total World	Total OPEC	Total Non-OPEC	Difference Non-OPEC-OPEC
1979	13.08	13.03	13.44	+0.41
1980	28.84	28.30	31.94	+3.64
1981	35.49	34.82	38.54	+3.72
1982	34.18	34.13	34.35	+0.22
1983	33.00	33.54	31.72	−1.82
1984	28.61	28.59	28.65	+0.06
1985	28.33	28.43	28.16	−0.27
1986	27.10	27.81	26.14	−1.67
1987	16.24	16.10	16.44	+0.34
1988	16.57	16.77	16.21	−0.56
1989	13.58	13.36	14.06	+0.70
CHANGE 1981 to 1989				
Actual	−21.91	−21.46	−24.48	
Percentage	−61.7 %	−61.6 %	−63.5 %	
CHANGE 1979 to 1981				
Actual	+ 22.41	+ 21.79	+ 25.10	
Percentage	+171.3 %	+167.2 %	+186.8 %	

Source: Energy Information Administration

PRICE–ARABIAN LIGHT CRUDE

— (U.S. dollars per barrel) —

Year	Average government selling price	Average spot market price	Difference
1975	10.46	10.70	+ 0.24
1976	11.51	11.63	+ 0.12
1977	12.09	12.43	+ 0.34
1978	12.70	13.00	+ 0.30
1979	13.34	29.89	+16.55
1980	26.00	35.69	+ 9.69
1981	32.00	34.30	+ 2.30
1982	34.00	31.76	− 2.24
1983	34.00	28.80	− 5.20
1984	29.00	27.80	− 1.20
1985	29.00	26.60	− 2.40
1986	28.00	23.00	− 5.00
1987	17.53	17.29	− 0.24
1988	13.43	13.28	− 0.15

Source: Energy Information Administration

These capacity numbers exclude some capacity in Iran and Iraq that was damaged or was shut in due to the war. Iran's production prior to the war was close to 6 million b/d. But its present capacity is estimated at only around 3.4 million b/d. Iraq has been rapidly developing reserves but production capacity has also been limited due to the war.

It is difficult to determine how much additional capacity is or will be available in those two countries now that the war has stopped. The CIA's estimate of Iranian capacity has already been boosted 400,000 b/d. There will undoubtedly be additional capacity added to OPEC in these two countries now that the hostilities have ceased for any extended period of time. In fact, one of the key determinants of the level of prices over the next few years may be the production levels adopted by Iran and Iraq. If they attempt to add considerably to present production levels, it will put additional downward pressure on prices.

OPEC adopted a very aggressive pricing policy when demand and capacity were in line. It took advantage of the dependency upon oil to fuel economic growth. But because OPEC led the way in boosting prices, when demand fell it resulted in a drop in demand for OPEC oil.

OPEC production peaked in 1977 at 31.7 million b/d. This was 64.5% of free-world production. By 1982, for the first time in its history, OPEC production fell below 50% of free-world production. In that year, OPEC output was 19.93 million b/d, 47.4% of free-world output.

By 1984, OPEC production had fallen to 18.5 million b/d, a drop of 41.7%. This was only 43% of total free-world production. And in 1985, OPEC production fell another 6.8% to 17.215 million b/d. This was 40.5% of non-communist output, and 29.9% of total world production. OPEC output had fallen 45.7% from the 1977 peak, a drop of 14.465 million b/d. And the drop wasn't because of a drop in capacity, but rather it caused available capacity to be shut in.

This drastic drop in market share is one of the reasons OPEC tried adopting a market share policy in 1986. And with sharply lower prices demand for OPEC oil

OECD* PETROLEUM STOCKS

	(Million barrels)								1983/1980		1988/1983	
	1980	1981	1982	1983	1985	1986	1987	1988	Change	% change	Change	% change
Canada	164	161	136	121	113	111	126	119	− 43	−26.2	− 2	− 1.7
France	243	214	193	153	139	127	127	140	− 90	−37.0	−13	− 8.5
Italy	170	167	179	149	157	155	169	155	− 21	−12.4	+ 6	+ 4.0
Japan	495	482	484	470	494	509	540	538	− 25	− 5.1	+68	+14.5
United Kingdom	168	143	125	118	123	124	121	112	− 50	−29.8	− 6	− 5.1
United States	1,392	1,484	1,430	1,454	1,519	1,593	1,607	1,597	+ 62	+ 4.5	+143	+ 9.8
West Germany	319	297	272	249	233	252	259	266	− 70	−21.9	+17	+ 6.8
Other OECD	636	583	557	541	506	547	525	519	− 95	−14.9	−22	− 4.1
Total OECD	**3,587**	**3,531**	**3,376**	**3,255**	**3,284**	**3,474**	**3,474**	**3,446**	**−332**	**− 9.3**	**+191**	**+ 5.9**

*Organization of Economic Cooperation & Development.
Source: Energy Information Administration

rebounded in 1986, jumping up 13.6% to total liquids output of 19.56 million b/d.

But this policy also led to lower prices and lower OPEC revenues. In today's competitive market, it's impossible for OPEC to have it both ways, high market share and high price.

In 1987, OPEC gave up a bit of market share and got slightly higher prices. But they had a great deal of difficulty maintaining production discipline, and in 1988 they pushed more oil into the market and forced prices down again. Discipline returned, at least temporarily, in 1989 and prices moved back up. But there is no confidence that OPEC will have sufficient discipline or member control to prevent similar swings in the future.

NON-OPEC PRODUCTION. The OPEC countries are not the only crude oil producers in the world. In response to the higher prices engineered by OPEC, the production in non-OPEC, non-communist countries increased steadily from 1975 through 1985. This was a classical economic supply response to markedly higher prices.

Non-OPEC, non-communist production increased 55.5% from 16.255 million b/d in 1975 to 25.275 million b/d in 1985. Obviously, the OPEC-led increase in crude oil prices made oil production economical in a number of other areas of the world. The increases in non-OPEC production occurred throughout the world. Major increases have been recorded in Brazil, Colombia, and Mexico in the western hemisphere. Norway and the United Kingdom have boosted production substantially in Western Europe. Elsewhere, there have been large increases in Egypt, Angola, Malaysia and India. And new production has recently started up in Yemen. A number of these countries have become major exporters of crude oil and are in direct competition with the OPEC exporters.

Non-OPEC production fell slightly in 1986, declining 0.6%, 160,000 b/d, down to 25.09 million b/d. Most of the decline was attributable to the drop in U.S. liquids output. That drop was due to the sharp fall in prices. Much of the U.S. production in older smaller fields is high cost output. Therefore, some production was shut in when prices dipped.

With slipping U.S. production, total non-OPEC output fell another 95,000 b/d in 1987, to 24.995 million b/d. Production rebounded in 1988 increasing 180,000 b/d to 25.175 million b/d.

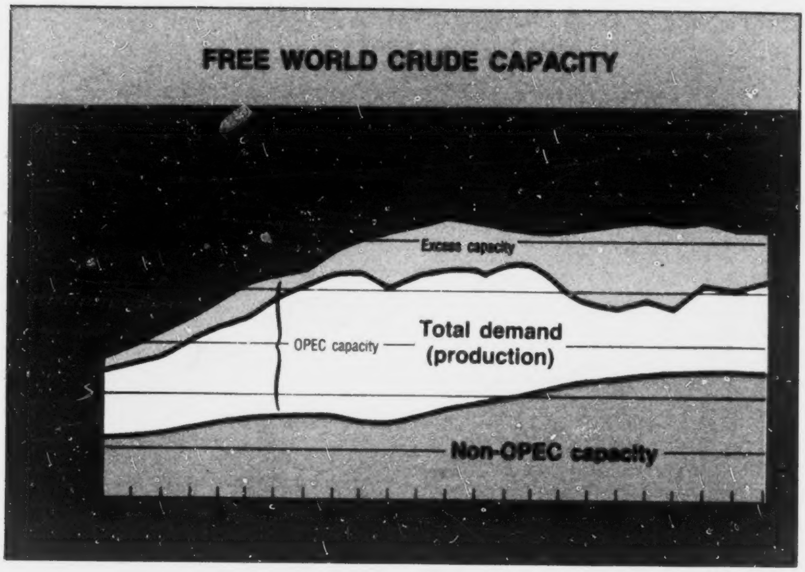
THE STRAIT OF HORMUZ—1988

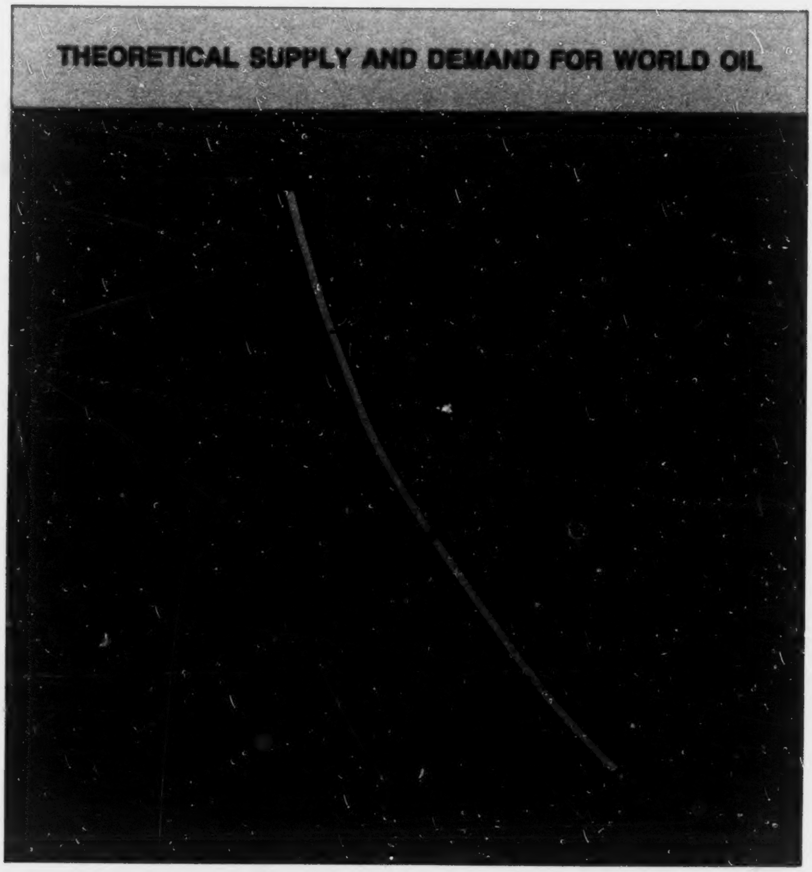
Country	Crude oil production (1,000 b/d)
Iran	2,240
Kuwait	1,335
Bahrain	43
Saudi Arabia	4,946
Qatar	346
United Arab Emirates	1,474
Total	**10,384**
Free world production	42,409
% of free world production	24.5
Exports via Strait of Hormuz	
Crude	5,500
Products	1,000
Total	**6,500**
Free world crude imports	19,361
% of free world crude imports	28.4%
Free world crude & product imports	26,243
% of free world crude & product imports	24.8%

Source: Author's estimates

In addition to increasing non-OPEC non-communist production, the U.S.S.R. was increasing production and exports. A substantial portion of the exports were to the non-communist countries. This added to the crude glut and increased the impact on OPEC.

The U.S.S.R. is the world's largest producer. U.S.S.R. output moved up 26% between 1975 and 1983. Their production fell 3% to 12.15 million b/d in 1985 and there was some question as to how long this level of production could be sustained. However, they did manage to boost production up to 12.56 million b/d in 1986, and 12.74


FREE WORLD CRUDE CAPACITY


THEORETICAL SUPPLY AND DEMAND FOR WORLD OIL

million b/d in 1987. Production remained close to this level in 1988 at 12.705 million b/d.

In addition, the U.S.S.R. has a program to replace internal oil consumption with natural gas. This policy will free more oil for export to the West, and continue to add an element to the excess capacity situation in the market oriented world.

With Chinese production also on the rise, total communist production moved up to 15.87 million b/d in 1987, up 33.4% since 1975. Production in 1988 was 15.875 million b/d.

THE OPEC EXCESS CAPACITY. It is this massive excess capacity, which developed in the OPEC countries, that has put a constant downward pressure on crude oil prices in recent years.

Recognizing the problem caused by the excess capacity, OPEC has tried to stabilize prices by establishing production quotas for individual countries and the group as a whole. However, few of the countries, other than Saudi Arabia, have exhibited the production discipline necessary to make the quotas work. The willingness of Saudi Arabia and a few other OPEC members to show some restraint managed to prevent a much-earlier free-fall in prices. But even with a substantial effort on the part of Saudi Arabia, it was impossible to stabilize prices. Prices slipped slowly downward from 1981 through 1985.

Trying to prop up and stabilize prices in the face of the overhanging excess capacity is a complex matter. It encompasses the perceived value of oil on the

WORLDWIDE OIL REFINING THROUGHPUTS

	1978	1979	1980	1981	1982	1983 (1,000 b/cd)	1984	1985	1986	1987	1988	% change 88/78	% change 88/79
U.S.	14,780	14,465	13,520	12,470	11,775	11,685	12,045	12,005	12,715	12,855	13,295	−10.0	−8.1
Canada	1,820	1,960	2,085	1,945	1,650	1,545	1,570	1,495	1,475	1,495	1,570	−13.7	−19.9
Latin America	5,975	6,220	6,460	6,575	6,080	5,825	5,715	5,450	5,480	5,525	5,450	−8.8	−12.4
Western Europe	12,855	13,665	12,330	10,970	10,075	9,710	9,790	9,490	10,060	9,950	10,280	−20.0	−24.8
Middle East	2,535	2,365	2,445	2,205	2,245	2,515	2,665	2,795	2,950	2,970	3,140	23.9	32.8
Africa	1,280	1,355	1,460	1,525	1,735	1,920	1,975	2,015	2,095	2,170	2,200	71.9	62.4
Japan	4,240	4,340	4,015	3,630	3,360	3,255	3,355	3,120	2,990	2,910	2,990	−29.5	−31.1
Southeast Asia	2,330	2,450	2,370	2,480	2,335	2,380	2,455	2,650	2,765	2,750	2,880	23.6	17.6
South Asia	645	675	705	795	840	880	885	1,020	1,120	1,150	1,160	79.8	71.9
Australasia*	690	700	640	655	625	605	615	580	590	570	590	−14.5	−15.7
Total Non-Communist World	**47,150**	**48,195**	**46,030**	**43,250**	**40,720**	**40,320**	**41,070**	**40,620**	**42,240**	**42,345**	**43,555**	**−7.6**	**−9.6**
Communist	12,875	13,230	13,320	13,420	13,575	13,675	13,885	14,165	14,500	14,580	14,755	14.6	11.5
Total World	**60,025**	**61,425**	**59,350**	**56,670**	**54,295**	**53,995**	**54,955**	**54,785**	**56,740**	**56,925**	**58,310**	**−2.9**	**−5.1**

*Includes Australia and New Zealand.

Source: British Petroleum

WORLDWIDE OIL REFINING CAPACITIES

Country/Area	1978	1979	1980	1981	1982	1983 (1,000 bc/d)	1984	1985	1986	1987	1988	% change 88/78	% change 88/81
NORTH AMERICA													
U.S.	17,375	17,920	18,250	18,290	16,860	15,865	15,660	15,460	15,460	15,565	15,915	−8.4	−13.0
Canada	2,340	2,315	2,150	2,155	2,260	2,025	2,015	2,075	2,080	1,820	1,890	−19.2	−12.3
Total North America	**19,715**	**20,235**	**20,400**	**20,445**	**19,120**	**17,890**	**17,675**	**17,535**	**17,540**	**17,385**	**17,805**	**−9.7**	**−12.9**
LATIN AMERICA													
Argentina	660	660	690	690	690	690	680	665	670	690	690	4.5	—
Brazil	1,230	1,230	1,375	1,530	1,530	1,400	1,305	1,305	1,320	1,395	1,410	14.6	−7.8
Mexico	990	1,340	1,475	1,525	1,620	1,630	1,790	1,680	1,790	1,790	1,790	80.8	17.4
Netherlands Antilles	840	840	840	780	780	780	740	320	320	320	320	−61.9	−59.0
Trinidad	465	465	455	455	375	375	320	260	300	300	300	−35.5	−34.1
Venezuela	1,445	1,445	1,425	1,405	1,360	1,225	1,225	1,230	1,225	1,200	1,200	−17.0	−14.6
Others	2,545	2,645	2,580	2,520	2,380	2,205	1,980	1,695	1,715	1,720	1,790	−29.7	−29.0
Total Latin America	**8,175**	**8,625**	**8,840**	**8,905**	**8,735**	**8,305**	**7,930**	**7,265**	**7,340**	**7,415**	**7,500**	**−8.3**	**−15.8**
WESTERN EUROPE													
Belgium	1,030	1,020	1,020	965	720	720	720	720	710	705	705	−31.6	−26.9
France	3,445	3,420	3,320	3,230	2,745	2,370	2,190	2,175	2,040	1,900	1,810	−47.5	−44.0
Italy	4,205	4,205	4,140	3,990	3,500	3,365	2,745	2,585	2,555	2,465	2,345	−44.2	−41.2
Netherlands	1,815	1,815	1,775	1,775	1,590	1,610	1,435	1,380	1,380	1,395	1,395	−23.1	−21.4
Spain	1,375	1,475	1,425	1,550	1,550	1,440	1,440	1,440	1,420	1,420	1,420	3.3	−8.4
United Kingdom	2,515	2,460	2,460	2,360	2,135	2,105	1,935	1,865	1,835	1,820	1,805	−28.2	−23.5
West Germany	3,090	3,040	3,095	2,955	2,520	2,280	2,115	1,750	1,680	1,615	1,645	−46.8	−44.3
Others	2,880	2,665	2,820	2,830	2,945	2,745	2,705	2,750	2,710	2,630	2,840	−1.4	0.4
Total Western Europe	**20,355**	**20,100**	**20,055**	**19,655**	**17,705**	**16,635**	**15,285**	**14,665**	**14,330**	**13,950**	**13,965**	**−31.4**	**−28.9**
MIDDLE EAST													
Bahrain	250	250	250	250	250	250	250	250	250	250	250	—	—
Iran	1,045	1,045	1,225	625	625	600	530	530	530	530	530	−49.3	−15.2
Iraq	230	265	265	265	265	200	300	320	320	320	320	39.1	20.8
Kuwait	575	575	575	530	545	590	590	630	620	635	745	29.6	40.6
Saudi Arabia	635	635	495	660	865	865	865	1,115	1,125	1,375	1,375	116.5	108.3
Others	640	770	755	920	1,015	1,055	980	965	1,005	1,095	1,115	74.2	21.2
Total Middle East	**3,375**	**3,540**	**3,565**	**3,250**	**3,565**	**3,560**	**3,515**	**3,810**	**3,850**	**4,205**	**4,335**	**28.4**	**33.4**
Africa	1,730	2,000	2,060	2,035	2,355	2,340	2,540	2,555	2,550	2,645	2,695	55.8	32.4
ASIA AND AUSTRALASIA													
Japan	5,285	5,285	5,675	5,675	5,500	4,975	4,975	4,975	4,705	4,460	4,325	−18.2	−23.8
Indonesia	535	535	515	515	515	760	760	780	780	780	780	45.8	51.5
Singapore	1,040	1,040	1,020	1,020	1,020	1,020	1,020	1,020	960	860	860	−17.3	−15.7
Other Southeast Asia	1,650	1,810	1,890	1,940	1,940	1,940	2,120	2,005	2,105	2,110	2,110	27.9	8.8
South Asia	825	825	870	885	995	1,020	995	1,150	1,225	1,210	1,210	46.7	36.7
Australasia*	785	800	810	815	815	815	785	705	740	730	740	−5.7	−9.2
Total Asia and Australasia	**10,120**	**10,295**	**10,780**	**10,850**	**10,785**	**10,530**	**10,655**	**10,635**	**10,515**	**10,150**	**10,025**	**−0.9**	**−7.6**
Total Non-Communist World	**63,470**	**64,795**	**65,700**	**65,140**	**62,265**	**59,260**	**57,600**	**56,465**	**56,125**	**55,750**	**56,325**	**−11.3**	**−13.5**
COMMUNIST													
China	1,600	1,900	1,900	1,810	2,000	2,050	2,150	2,150	2,170	2,230	2,340	30	29.3
U.S.S.R.	10,000	10,500	10,700	11,600	11,750	12,000	12,000	12,000	12,260	12,260	12,260	22.6	5.7
Others	2,775	2,825	2,910	3,125	3,170	3,170	3,170	3,170	3,265	3,390	3,390	22.2	8.5
Total Communist	**14,575**	**15,225**	**15,510**	**16,535**	**16,920**	**17,220**	**17,320**	**17,320**	**17,695**	**17,880**	**17,990**	**23.4**	**8.8**
Total World	**78,045**	**80,020**	**81,210**	**81,675**	**79,185**	**76,480**	**74,920**	**73,785**	**73,820**	**73,630**	**74,315**	**−4.8**	**−9.0**

*Includes Australia and New Zealand.

Source: British Petroleum

part of the OPEC members, the cost of production, the cost and availability of competing fuels, and the internal politics of the OPEC members.

To get a better grasp of this problem, the following discussion points out some of the key factors that have an impact on the oil price/production situation. And the discussion will trace some recent OPEC decisions and their impact on the oil markets.

OPEC production, particularly in the Persian Gulf area, is some of the lowest cost in the world. But the aggressive pricing policies of OPEC resulted in OPEC oil being the highest priced in the world. The result in the importing countries has been that, whenever possible, OPEC oil supplies have been replaced by domestic crude or other, less costly, imported crude.

OPEC has become the swing producer, filling the gap between demand and non-OPEC production. All excess capacity, except for some minor exceptions, has been thrust upon OPEC. About 47% of installed OPEC capacity, 14 million b/d out of 30 million b/d was shut in during 1985. This improved slightly in 1986 and 1987 to 12 million b/d out of 30 million b/d, or 40% of installed OPEC capacity shut in. The increase in OPEC production in 1988 reduced the excess capacity to 9.8 million b/d. But this was still 33% of capacity.

The OPEC cartel pricing policies resulted in an oil industry turned upside down, with the cheapest production shut in and the most expensive production producing at full capacity.

To get a clearer perspective on what has been happening in the world oil industry and with world oil prices, it might be advantageous to take a look from the viewpoint of classical economic theory.

In classical theory, price is the determinant of supply and demand. When external forces create a situation where there is not equilibrium, i.e. demand and supply do not meet at a market clearing price, then there are economic forces at work attempting to move the market toward equilibrium.

Prior to the establishment of OPEC, there was some justification in assuming that the international oil companies held the price below the equilibrium price. This created a situation of excess demand. The oil companies met demand by concentrating on production. And pricing was based on current production costs. Little emphasis was given to the long-run value of reserves in the ground. The result was a rapid increase in demand as cheap oil energy fueled economic expansion worldwide.

When OPEC gained control over production, they placed more emphasis on the long-term value and life of their oil reserves. They attempted to maximize immediate return rather than output. And they searched for the price level that the market would bear. To a certain extent, OPEC was using the world as a large economic laboratory to test the elasticity of demand for crude oil. The result of OPEC's pricing policy was a reduction in demand and increased supply, netting out to an excess supply situation.

However, market forces began to take hold and movement started toward reestablishing equilibrium. This movement took the form of falling prices, increased demand and a reduction in the rate of increase in the non-OPEC crude supply.

A brief review of what happened to prices over the past fifteen years will help clarify this classical description.

The official posted price of the OPEC market crude, Saudi Arabian light, was boosted 294.2% from $2.75/bbl in 1973 to $10.84/bbl in 1974. The demand response was minimal at that time, since oil was already underpriced.

Then the price was moved up slowly to $12.70/bbl in 1978, an additional increase of 17.2%. However, because of the sharp increase in the rate of inflation, the real price actually fell during this period. Therefore, demand for crude oil continued to move up even though the price had increased substantially.

Demand is more responsive to the real price than the actual price since economic decisions to consume are based on the relative cost of an item compared to other necessary purchases.

Since demand was still rising, OPEC decided to raise prices again and test the market. This time they boosted prices sharply from $12.70/bbl in 1978 to $34.00/bbl at the end of 1981, an additional increase of 167.7%. The overall price increase from 1973 through 1981 was +$31.25/bbl, up 1136.4%.

A price increase of that magnitude was bound to attract the attention of oil consumers. Demand reacted to this price increase. Conservation, fuel switching to other energy, and a slow-down in economic activity led to a 19% drop in production in the non- communist world between 1979 and 1983. This drop in demand for oil, coupled with the increase in non-OPEC production, resulted in the huge excess capacity in the OPEC countries.

This excess capacity put substantial downward pressure on prices. The official OPEC market crude price fell to $28/bbl in 1985, a reduction of 17.6% from the peak $34 level. The average spot market price fell from $35.69/bbl in 1980 to an estimated $27.80/bbl in 1984, a drop of 22.1%.

This fall in prices also got a reaction from fuel consumers. Free-world demand responded to this sharp drop in prices, and moved up 2.1% in 1984.

Another phenomenon occurred along with the development of a huge excess capacity. The growth in excess capacity led to a shift in trading from contract to the spot market. With crude readily available there was less need or advantage in long term contracts.

When prices moved up sharply in 1979-1981, spot market prices were well-above official prices. The average spot market price in 1979 was $12.60/bbl higher than the contract price. This difference undoubtedly prompted OPEC to push up the official price for their crude oil. With the development of the excess capacity, spot market prices fell below official prices and led to the drop in official prices.

The volume of crude traded in the spot market grew substantially from 1981 to 1985. By 1985, the vast majority of transactions were spot market transactions or contract trades based on spot market prices. There has been some attempt to reestablish contract prices, but the volatile nature of prices has made this impossible. Instead, what has been established are crude supply contracts with the price based on some current market price indicator.

In addition to the shift to spot market trading, the more speculative nature of crude trading and prices resulted in the development of a futures market. This market has grown rapidly, and is today one of the most watched indicators in the oil industry.

In five years, the number of crude oil contracts traded on the New York Mercantile Exchange has taken off, with 350 million bbl in 1983, 1,840 million bbl in 1984, 3,981 million bbl in 1985, 8,314 million bbl in 1986, 14,582 million bbl in 1987 and 18,859 million bbl in 1988.

With the movement to spot market transactions and the development of the futures market, OPEC lost a lot of control over pricing. They had a market with higher oil prices but no longer had the control over prices the international oil companies once had.

In an attempt to prevent a collapse of prices, OPEC established production quotas for each member country. OPEC set a production quota in 1983 of 17.5 million b/d. However, prices continued to slide and the production quota was reduced to 16 million b/d in 1984. There was considerable cheating, with a number of OPEC countries producing above their quotas.

Saudi Arabia was willing to play the role of swing producer and they cut production sharply in order to support the worldwide price. Saudi Arabian production fell 6.39 million b/d, 64%, from 9.99 million b/d in 1980 to 3.6 million b/d in 1985. Other OPEC producers showed some restraint, and the result was a sufficient reduction in total production to prevent a free-fall in prices.

In order to prop up prices, Saudi Arabia was forced to shut in a substantial volume of production. After awhile it became apparent that they were absorbing a disproportionate percentage of the production cutback that was required to support prices.

In the summer of 1985, Saudi production temporarily dipped below 2 million b/d in their role of swing producer. And it became apparent that with expected weak demand in 1986, their production would fall even further if they continued to be the supply source of last resort.

So in the fall of 1985 the Saudis unilaterally arranged, with several selected purchasers, to sell their oil using a new net-back pricing arrangement. They were willing to accept a lower price for their crude oil that was based on the net-back value of the crude oil after product sales and refining. This was done by the Saudis in order to increase their share of the crude oil market and to send a message to the other OPEC producers: a message that they would no longer carry the entire burden of supporting prices. They abandoned the role of swing producer and have never returned.

In a subsequent meeting, OPEC policy was also changed to one aimed at regaining market share rather than supporting prices. But this turned out to be a disaster. This shift in OPEC policy brought the full weight of the excess crude capacity bearing down on worldwide crude oil prices. The result was a collapse in the price of crude oil in early 1986, when winter demand began to slacken.

The average price of world export crude fell from $27.10/bbl at the end of 1985 to a low of $9.35/bbl the first week of August 1986, a drop of 65%. This did stimulate

FREE WORLD ACTIVE RIG COUNT

Region	(Annual average)															
	1979	1980	1981	1982	1983	1984	1985	1986			1987			1988		
	Total	Total	Total	Total	Total	Total	Total	Land	Off.	Total	Land	Off.	Total	Land	Off.	Total
Canada	339	401	263	200	201	259	311	174	4	178	179	2	181	193	2	195
United States	2,176	2,910	3,969	3,117	2,229	2,429	1,976	847	123	970	816	120	936	813	124	937
North America	**2,515**	**3,311**	**4,232**	**3,317**	**2,430**	**2,688**	**2,287**	**1,021**	**127**	**1,148**	**995**	**122**	**1,117**	**1,006**	**126**	**1,132**
Argentina	63	76	70	67	73	82	81	47	0	47	60	1	61	63	0	63
Brazil	60	72	81	94	83	70	76	46	31	77	35	25	60	28	11	39
Mexico	205	215	218	202	187	196	196	132	31	163	112	31	143	121	34	155
Venezuela	47	52	63	69	41	30	33	16	13	29	9	9	18	15	10	25
Others	65	66	89	90	67	61	57	44	11	55	45	11	56	40	13	53
Latin America	**440**	**481**	**521**	**522**	**451**	**439**	**443**	**285**	**86**	**371**	**261**	**77**	**338**	**267**	**68**	**335**
India	40	43	44	50	56	57	63	55	15	70	94	22	116	106	25	131
Indonesia	66	77	86	92	88	82	80	42	20	62	25	12	37	33	11	44
Others	111	122	125	135	131	119	118	76	26	102	65	20	85	59	27	86
Far East	**217**	**242**	**255**	**277**	**275**	**258**	**261**	**173**	**61**	**234**	**184**	**54**	**238**	**198**	**63**	**261**
Algeria	109	111	91	81	54	27	35	41	0	41	40	0	40	32	0	32
Libya	33	41	33	31	24	26	30	20	0	20	12	0	12	14	2	16
Nigeria	18	20	23	27	17	11	10	7	3	10	6	5	11	8	6	14
Others	41	47	66	70	52	41	43	10	16	26	8	19	27	11	21	32
Africa	**201**	**219**	**213**	**209**	**147**	**105**	**118**	**78**	**19**	**97**	**66**	**24**	**90**	**65**	**29**	**94**
Germany, Fed. Rep.	21	22	26	31	25	19	20	19	0	19	12	0	12	9	0	9
Italy	21	19	32	36	26	26	40	24	9	33	20	6	26	17	7	24
United Kingdom	34	48	58	58	42	60	63	7	36	43	4	40	44	5	52	57
Others	76	90	102	110	92	98	110	56	33	89	47	26	73	47	32	79
Western Europe	**152**	**179**	**218**	**237**	**185**	**203**	**233**	**106**	**78**	**184**	**83**	**72**	**155**	**78**	**91**	**169**
Abu Dhabi	20	23	31	41	35	29	21	8	7	15	3	6	9	3	5	8
Egypt	21	26	27	36	35	36	37	17	16	33	14	9	23	11	10	21
Saudi Arabia	22	25	29	29	26	16	11	5	1	6	4	1	5	4	1	5
Turkey	9	24	26	34	26	24	25	27	0	27	26	0	26	21	1	22
Others	72	79	57	60	84	92	107	92	5	97	74	2	76	87	4	91
Middle East	**144**	**177**	**170**	**200**	**206**	**197**	**201**	**149**	**29**	**178**	**121**	**18**	**139**	**126**	**21**	**147**
Australia	11	15	23	32	25	34	31	9	6	15	13	3	16	13	5	18
Others	2	3	3	2	3	3	6	4	1	5	4	1	5	3	1	4
South Pacific	**13**	**18**	**26**	**34**	**28**	**37**	**37**	**13**	**7**	**20**	**17**	**4**	**21**	**16**	**6**	**22**
Total Free World	**3,682**	**4,627**	**5,635**	**4,796**	**3,722**	**3,927**	**3,580**	**1,825**	**407**	**2,232**	**1,727**	**371**	**2,098**	**1,756**	**404**	**2,160**
Total excl. North America	**1,167**	**1,316**	**1,403**	**1,479**	**1,292**	**1,239**	**1,293**	**804**	**280**	**1,084**	**732**	**249**	**981**	**750**	**278**	**1,028**

Source: Baker Hughes Inc.

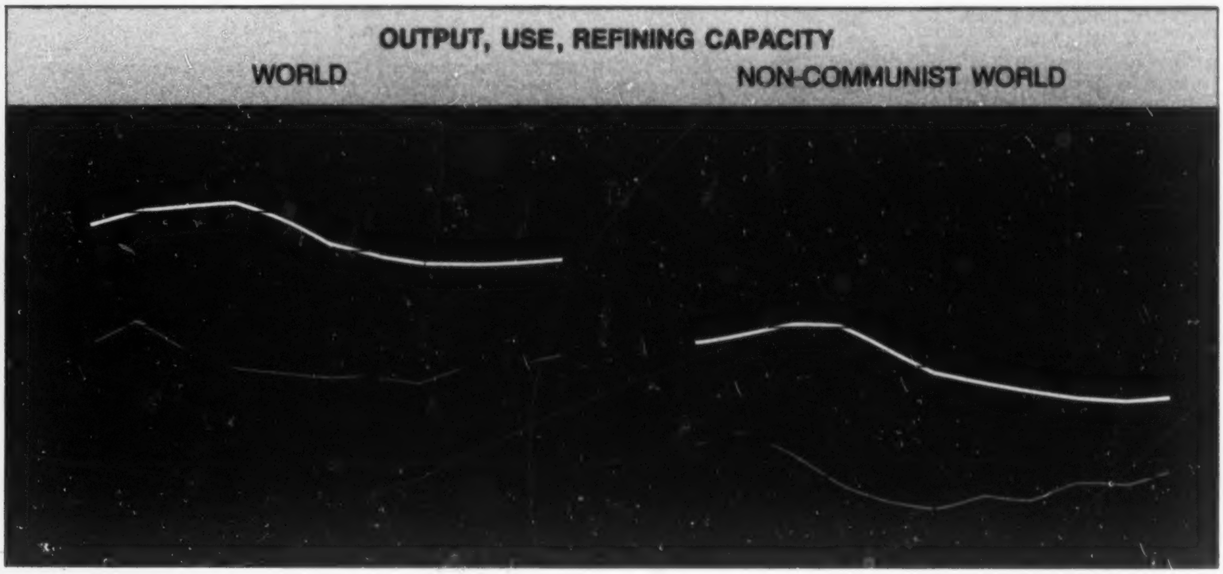
demand for OPEC oil and did curtail investment, and in some cases, production of competing high cost oil. OPEC did achieve the goal of increased market share. But there was a huge cost associated with the increase in market share, since the drop in prices far exceeded the increase in output.

OPEC found out that there was a tremendous cost for gaining market share at the expense of the price level. August production in 1986 at 21.028 million b/d was up 38.6% over August 1985. And cumulative production for the first eight months of 1986 was up 19.9% from 1985. But prices had fallen 65% and it was obvious that increased volume could not make up for lost revenue due to lower prices. If OPEC wanted increased market share it would be at the cost of substantially lower revenues.

The total value of OPEC crude exports had fallen from $282 billion in 1980 to $132 billion in 1985, a drop of 53.4%. Revenues for 1986 fell another 42% to $77 billion. The policy of trying to gain a greater market share cost OPEC $56 billion in revenue. This was sufficient incentive to reestablish a workable quota agreement.

OPEC production fell in 1987, about 2.7%, but estimated revenues were up substantially. Estimated revenues increased about 13% to $87 billion.

OPEC wasn't able to establish group production discipline, Saudi



OUTPUT, USE, REFINING CAPACITY

WORLD

NON-COMMUNIST WORLD

Arabia abandoned the role of sole swing producer, and the result was a collapse in prices in the spring of 1986. OPEC supposedly learned a lesson from this experience. Quotas were reestablished and prices moved back up in 1987.

But the lesson was learned very well and 1988 in many ways turned out to be a repeat of 1986, although not quite as severe. In 1988 as in 1986, OPEC found it very difficult to sustain production discipline with that huge excess production capacity readily available. In 1988, over-production again weakened prices. A number of OPEC countries boosted output over the quota and prices fell. The average export price of OPEC crude oil fell from $16.35/bbl in January of 1988 to $10.75/bbl in October. And it appeared the lesson had to be learned all over again.

OPEC established new more realistic production quotas starting in January 1989. And some of the countries that were over producing exhibited sufficient discipline to tighten the market and help firm up prices. In addition, OPEC was helped out by rising demand that was stimulated by the low prices. This helped clear the market and support prices at a higher level. Prices moved up to $15.04/bbl in January 1989 and to $18.24/bbl in April. For the remainder of the year export prices remained relatively stable moving between $15.50/bbl and $17.50/bbl.

PRICING CRUDE OIL. It appears quite apparent that the key to establishing a price for crude or just stabilizing crude prices is the OPEC adherence to a reasonable quota. This is evident from the events of 1986, 1987, 1988 and 1989, when crude prices moved through a couple of major cycles.

OPEC abandoned their attempt to increase world market share by reestablishing production quotas in late 1986. First they adopted a set of temporary emergency quotas in September 1986, to stop the free fall in crude prices. And then they adopted a more formal set of quotas at the end of 1986 to help sustain a higher price level.

The average price of OPEC export crudes fell from $27.81/bbl at year end 1985, to $9.59/bbl in August 1986, during the OPEC experiment with increasing market share. When OPEC announced that they were adopting temporary quotas the price moved back up to $12.50/bbl, and remained between $12.30/bbl and $14.70/bbl for the remainder of 1986. Following the adoption of formal quotas in December 1986, the average price of OPEC export crude moved up over $17/bbl. And the price stayed above $17/bbl for all of 1987. The key to the higher price level was the adoption and adherence to the quotas, and the abandonment of net-back pricing.

Under net-back contracts, the price of the crude traded is based upon the value or selling prices of the refined products. The value of

OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1987	Change 1987-1982	% change 1987/1982
	(1,000 b/cd)				
Algeria	471.2	471.2	471.2	—	—
Ecuador	94.5	94.5	139.0	44.5	47.1
Gabon	44.0	44.0	21.0	-23.0	-52.3
Indonesia	473.4	473.4	738.7	265.3	56.0
Iran	1,320.0	670.0	615.0	-55.0	-8.2
Iraq	305.5	215.5	365.5	150.0	69.6
Kuwait	594.0	594.0	720.0	126.0	21.2
Libya	117.0	117.0	342.0	225.0	192.3
Nigeria	234.0	234.0	243.0	9.0	3.8
Qatar	10.5	13.0	63.0	50.0	384.6
Saudi Arabia	878.0	765.0	1,490.0	725.0	94.8
United Arab Emirates	13.5	121.5	162.0	40.5	33.3
Venezuela	1,444.9	1,323.1	1,258.3	-64.8	-4.9
Total OPEC	**6,000.5**	**5,136.2**	**6,628.7**	**1,492.5**	**29.1**

Source: OPEC Statistical Bulletin

WORLDWIDE EXCESS PRODUCTIVE CAPACITY

	Production			Productive capacity*			Excess capacity				
										% of	
	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	OPEC	Non-OPEC	Total Non-Comm	total capacity	total production
	(1,000 b/d)										
1961	9,364	9,319	18,683	10,150	10,050	20,200	786	731	1,517	7.51	8.12
1962	10,508	9,663	20,171	11,350	10,450	21,800	842	787	1,629	7.47	8.08
1963	11,514	10,036	21,550	12,450	10,850	23,300	936	814	1,750	7.51	8.12
1964	12,984	10,206	23,190	14,050	11,050	25,100	1,066	844	1,910	7.61	8.24
1965	14,339	10,552	24,891	15,500	11,400	26,900	1,161	848	2,009	7.47	8.07
1966	15,770	11,235	27,005	17,050	12,150	29,200	1,280	915	2,195	7.52	8.13
1967	16,850	12,155	29,005	18,200	13,150	31,350	1,350	995	2,345	7.48	8.08
1968	18,786	13,114	31,900	20,300	14,200	34,500	1,514	1,086	2,600	7.54	8.15
1969	20,907	13,569	34,476	22,600	14,650	37,250	1,693	1,081	2,774	7.45	8.05
1970	23,413	14,515	37,928	25,300	15,700	41,000	1,887	1,185	3,072	7.49	8.10
1971	25,326	14,575	39,901	27,400	15,750	43,150	2,074	1,175	3,249	7.53	8.14
1972	27,094	14,845	41,939	29,300	16,050	45,350	2,206	1,205	3,411	7.52	8.13
1973	30,989	14,942	45,931	33,500	16,150	49,650	2,511	1,208	3,719	7.49	8.10
1974	30,729	14,593	45,322	34,800	15,750	50,550	4,071	1,157	5,228	10.34	11.54
1975	27,155	14,418	41,573	36,100	15,600	51,700	8,945	1,182	10,127	19.59	24.36
1976	30,738	14,548	45,286	37,400	15,750	53,150	6,662	1,201	7,863	14.79	17.36
1977	31,278	15,595	46,873	38,700	16,850	55,550	7,422	1,255	8,677	15.62	18.51
1978	29,805	17,304	47,109	36,480	18,700	55,180	6,675	1,396	8,071	14.63	17.13
1979	30,928	17,708	48,636	34,260	19,150	53,410	3,332	1,442	4,774	8.94	9.82
1980	26,890	18,310	45,200	32,730	19,800	52,530	5,846	1,484	7,330	13.95	16.21
1981	22,624	18,853	41,477	31,200	20,400	51,600	8,576	1,547	10,123	19.62	24.41
1982	18,584	19,768	38,352	31,200	21,400	52,600	12,616	1,632	14,248	27.09	37.15
1983	17,317	20,718	38,035	31,200	22,400	53,600	13,883	1,682	15,565	29.04	40.92
1984	17,442	21,922	39,364	31,000	23,700	54,700	13,558	1,778	15,336	28.04	38.96
1985	16,039	22,727	38,766	30,000	24,400	54,400	13,961	1,673	15,634	28.74	40.33
1986	18,074	22,443	40,517	30,000	24,550	54,550	11,926	2,107	14,033	25.73	34.63
1987	17,801	22,532	40,333	29,500	24,800	54,300	11,699	2,268	13,967	25.72	34.63
1988	19,665	22,744	42,409	29,500	24,700	54,200	9,835	1,956	11,791	21.75	27.80

*Estimated

WORLDWIDE EXPORT CRUDE OIL PRICES

Year	Official Sales and Term Contract Prices (Dollars per barrel - 1 January)				
	Saudi Arabia Arabian Light 34°	Nigeria Bonny Light 37°	United Kingdom Brent 38°	Mexico Isthmus 33°	U.S.S.R. Export Blend 32°
1979	13.34	14.80	15.70	14.10	13.20
1980	26.00	29.97	26.02	32.00	33.20
1981	32.00	40.00	39.25	38.50	39.25
1982	34.00	36.50	36.60	35.00	35.49
1983	34.00	35.50	33.50	32.50	31.20
1984	29.00	30.00	30.00	29.00	28.60
1985	29.00	28.00	28.65	29.00	28.00
1986	28.00	28.65	26.00	26.21	28.15
1987	16.15	17.13	18.25	17.00	18.30
1988	17.52	18.92	18.00	14.83	15.80
1989	13.15	15.05	15.80	14.53	14.55

Source: Energy Information Administration

the products that can be obtained from the specific type of crude oil are determined by the sales price during a specified time period. From this value are deducted the costs associated with refining the products and transporting the crude and a specified processing fee or refiner margin. The remainder is the net-back value or price of the crude, and represents the amount remitted to the producer. Net-back pricing shifts a great deal, if not all, of the price risk in the market to the producer.

Under net-back pricing refiners had a great deal of incentive to try to move large volumes of product by price competition. Under most net-back formulas refiners were virtually guaranteed a profitable margin on each barrel. So the incentive was for the refiner was in increasing the volume sold. The result was increased product demand and increased demand for crude oil, but also rapidly declining prices.

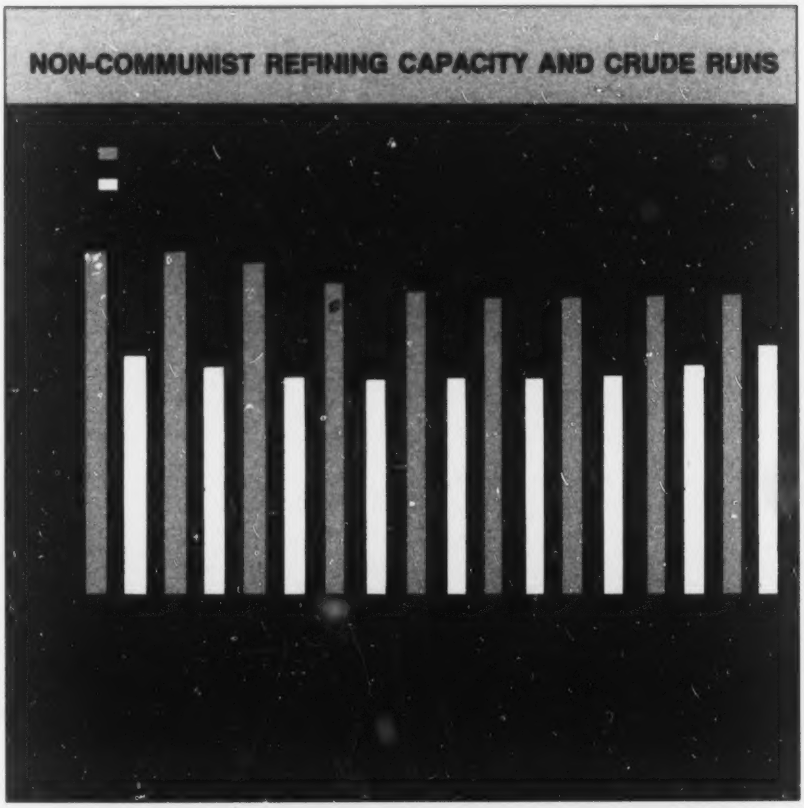
For a time it appeared that OPEC was trying to reestablish the old posted price system. But as expected not many purchasers were willing to commit to any long term contracts in today's volatile market.

OPEC export prices had been rather stable for an extended period in 1987, but this was mainly due to market conditions rather than an acceptance of posted prices by crude purchasers. The adherence to production levels close to the adopted quotas brought supply and demand close to equilibrium and stabilized prices.

OPEC may have regained some control over the market and the price of oil in 1987. But that control was dependent upon their ability to establish a quota that would tighten supply in the market. And it was dependent upon OPEC countries having the long term discipline to constrain production levels.

They flunked the test in 1988, by over-producing and driving down the price. And again it has cost them revenue.

As in the past, the key to future price stability will be OPEC production discipline and the selection of a quota that can sustain equilibrium between supply and demand. OPEC managed to do this fairly well in 1989, but they were helped out by higher than expected worldwide demand. There are some signs that the production discipline is eroding rapidly.

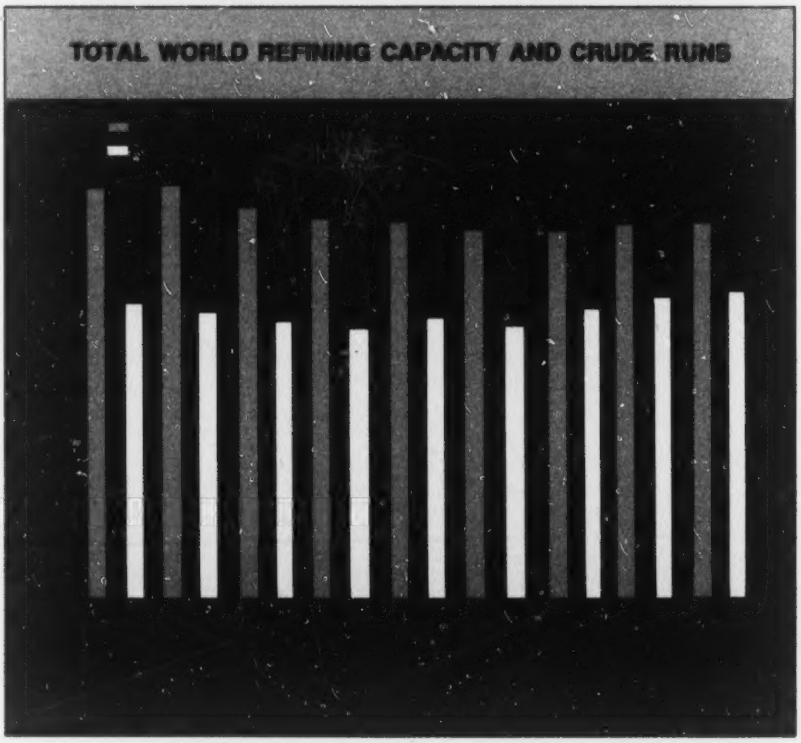


NON-COMMUNIST REFINING CAPACITY AND CRUDE RUNS

SUPPLY VULNERABILITY. This outlook is based upon expectations due to economic forces and doesn't attempt to forecast political events. However, a political upheaval would have some impact on worldwide supply.

Of most concern has been the possible closing of the Strait of Hormuz due to some conflict in that area. This was of particular concern during the Iran-Iraq war. This was of great concern since there was considerable action directed at tanker traffic during that conflict. But with the cessation of hostilities between Iran and Iraq this appears to be less of a concern. The probability of a closure of the Strait has been reduced substantially.

Dependency upon imports through the Strait of Hormuz has been reduced in recent years. Reduced worldwide imports and alternative pipeline routes that bypass the Strait have reduced the vulnerability. However, imports



TOTAL WORLD REFINING CAPACITY AND CRUDE RUNS are on the rise again and this will add to vulnerability. Four years ago, 8.4 million b/d, 36% of free-world imports, were coming through the Strait. At the present time, about 6.5 million b/d is being exported via the Strait of Hormuz. The free-world total imports are somewhere close to 26 million b/d. Therefore, 25% of total free-world import requirements would be affected if the Strait was closed.

Saudi Arabia has increased the capacity of their pipeline system to the Red Sea. Saudi Arabia presently has the capacity to move close to 4 million b/d via their pipeline system. If they fully utilized this capacity it would substantially reduce the flow through the Strait.

Although it appears that vulnerability has been reduced because of the end to the war, this will continue to remain a strategic channel for world oil supply.

U.S. imports are increasing rapidly, and this is therefore boosting the volume of crude and products in international trade. And even though some alternative routes have been developed, it is probable that crude moving through the Strait will increase. Iran is expected to boost output and Iraq will undoubtedly reestablish an export terminal in the Gulf. These moves will add to the volumes moving through the Strait.

If the Strait was closed for any reason the impact on prices would depend upon the perceived length of time it would be closed. If it appeared that the closing was only temporary, the industrial countries and international oil companies might simply draw down stock levels to meet the demand. However, industry stock levels are presently quite low and do not offer much of a buffer against a major supply disruption. However, strategic government stocks might be used if there were a temporary disruption.

It is still an area of vulnerability, but there is presently little thought given to a potential closing, and it doesn't appear to have much impact on industry decisions.

EXPLORATION. The search for oil throughout the non-communist world, outside the U.S., has not been fluctuating as wildly as crude oil prices. Oil importing countries find it financially advantageous to develop their own crude capacity. And in addition the international oil companies have found that there is substantially more profit margin in equity crude than in crude purchased from OPEC exporters. So they have continued the search in those areas where they can obtain favorable/profitable exploration/development agreements.

The result has been an active drilling rig count, outside the U.S. and Canada, that has held up fairly well during the recent period of falling or wildly fluctuating prices.

The number of active drilling rigs outside the U.S. and Canada peaked in 1982 at 1,479. The active rig count fell to 1,292 in 1973, and 1,239 in 1984 but then went back up to 1,293 in 1985. The rig count did fall 16.2% to an average 1,084 in 1986. However, this was less than half of the 35–40% drop in average crude oil prices. The count did slip again in 1987, to an average of 981 for the year. But by year end it had moved back up to 1050. And the average for 1988 increased to 1028. This is comparable to 1978 when the count averaged 1086.

Compared to the peak year of 1982, the international rig count for 1988 was down 30.5%. The price of crude oil on the other hand was down 60.4%. The rig count in 1989 has slipped and is expected to average 925 for the year. Uncertainty over prices appears to be the main reason for the decline.

The increases in activity in 1988 compared to 1987 were in all major geographic areas. But the largest increases were in the Far East and Europe. In 1989 there was a sharp decline in Latin America where the rig count was down close to 100. There were smaller drops in Europe, Africa and Asia-Pacific.

Until the collapse in prices in 1986 one of the major reasons for the high level of activity in the face of declining demand was the remaining relatively high price of oil. Since the increase in the price of oil far surpassed the general rate of inflation over the past decade, the profit margin increased considerably. Previously uneconomic or marginal fields were being developed throughout the world, and huge import bills encouraged countries without sufficient production to stimulate exploration activities.

One major result of this high level of exploration activity has been to prevent a major decline in worldwide crude reserves. In fact, coupled with the decline in demand/production, the increased exploration has resulted in an increase in reserves over the 1979–1980 level.

Looking to the future as oil becomes more difficult to find, particularly in large quantities, activity must increase in order to maintain reserves. This is particularly true in the non-OPEC areas. And the level of activity will be sustained and increased only if the price level moves up.

However, this does not appear to be an immediate problem. Total worldwide crude oil reserves were increased substantially during 1987 and 1988. Reserves at the start of 1989 were up 30.1%, an increase of 210 billion barrels, from two years earlier. Reserves as of January 1, 1989 were 907 billion barrels. Huge revisions and additions were made by four OPEC countries, Venezuela, United Arab Emirates, Iraq and Iran. This accounted for most of the massive increase. These figures don't include a massive upward revision made by Saudi Arabia in 1989. They boosted their reserve estimate up another 82 billion barrels.

One of the results of this substantial addition is that worldwide reserves at the start of 1989 were 41% higher than they were ten years earlier at the start of 1979. Non-communist reserves as of the first of 1989 were 823.6 billion barrels. This is up 50.4% from 1979. OPEC reserves at the first of 1989 were 676 billion barrels, which is 74.5% of total world reserves and 82.1% of total non-communist reserves. With the revisions for Saudi Arabia OPEC reserves would total 758.4 billion barrels, 76.6% of the world total and 83.7% of total non-communist reserves.

The reserves/production ratio was 35.2 years in 1975. This fell to 26.7 years in 1979, the year of peak worldwide production. In 1984, the ratio moved up to 31.7 years. With the huge upward revisions in reserves, this moved up to an estimated 42.7 years in 1988 and 42.9 years in 1989.

Worldwide reserves have been replaced and even increased throughout the past ten years. This was mainly due to the increased value of oil that stimulated increased exploration activity. The reserves/production ratio has been maintained and there is no apparent immediate pressure on oil availability. However, investment in exploration and production activity will have to be sustained if the reserves/production ratio is to be maintained at this level.

It is evident from the reserves profile that OPEC still holds the key position in future world supply. And unless activity is sustained in the non-OPEC areas, the OPEC dominance over production and prices will be re-established in the near future. It is evident that in the long run OPEC holds the reserve position to dominate the world oil industry.

REFINING. Another key element of the supply side of the equation is refining. The worldwide refining industry has gone through a somewhat similar cycle to that of production. That cycle has also been brought on by the volatile change in prices.

With the drop in demand for petroleum products, crude runs through refineries also fell sharply. As refinery runs fell, excess capacity developed in the refining industry. Refining capacity represents a substantial fixed investment in plant and equipment. Therefore, adjustment of capacity to the declining demand was a slow process.

There was an initial delay as refineries attempted to determine if the peaking of demand, and subsequent decline, was a temporary phenomenon; or to determine if it was a permanent demand adjustment that would require adjustment in refining capacity. Based on the long-term forecasts available at that time, that projected steadily increasing long-term demand, refineries initially adjusted by running at a lower utilization rate. As it became apparent that the downturn in demand was signaling a much lower level of demand for the long run, refineries realized that the industry was faced with a massive excess capacity.

Faced with sharply reduced, and in many cases, negative refining margins, refiners started to adjust capacity by mothballing or permanently closing facilities. Free-world refining capacity peaked in 1980 at 65.7 million b/d and remained relatively high in 1981 at 65.14 million b/d. After those years of reflection capacity was reduced at a more rapid rate and fell to 56.125 million b/d in 1986. Capacity fell again in 1987 to 55.75 million b/d and was down 9.95 million b/d, 15.1%, from the peak in 1980.

However, 1988 seems to have been a turning point in the cycle. Demand for petroleum products has been on the rise in recent years. In response non-communist refining capacity moved up to 56.325 million b/d in 1988, stopping the seven year slide. Increased demand led to additional capacity being added in the U.S. There were also net capacity additions in Canada, Latin America, Western Europe, the Middle East and Africa. These additions more than offset reductions in the Far East.

The reduction in demand for petroleum products in the early 1980's led to a drop in refinery throughput. And this resulted in a sharp drop in the refinery utilization rate. The refinery utilization rate for non-communist world refineries fell to 65.4% in 1982 from 74.3% in 1978. A lower utilization rate increases the unit cost of refined products and reduces refining margins. This was a great incentive to adjust refining capacity in an attempt to increase profitability.

A cut in crude refining capacity, and an increase in demand, boosted the rate up to 75.3% in 1986. It moved up to 76% in 1987 due to the increase in throughput and decline in capacity. This increased to 77.3% in 1988 as the 2.9% increase in throughput surpassed the 1% increase in capacity.

The improvement in the utilization rate over the last several years was primarily due to the reduction in capacity. But in 1986, 1987, and 1988 increased throughput due to the improvement in demand has made a major contribution to the improvement in the utilization rate.

This improvement in refining utilization has improved profitability in the refining sector of the industry. However, now there is another threat to refining profitability emerging, and that is the increase in OPEC refining capacity. It appears apparent that some of the OPEC countries intend to carve out a portion of the refined products market. OPEC has plans to increase their refining capacity substantially. Plans are now being reviewed to possibly boost capacity to 8.5 million b/d. OPEC countries will not only be supplying a much greater percentage of their own internal petroleum product requirements, but will also be expanding their role in the product export market.

OPEC refining capacity in 1987 was 6.6 million b/d. OPEC's 1987 capacity was up 29.1% from 1982.

OPEC PRODUCTION QUOTAS

	(1,000 b/d)					
Country	1984* quota	1984 production	1986 quota	1986 production	1988 quota	1988 production
Algeria	663	608	669	623	667	641
Ecuador	183	258	221	292	221	305
Gabon	137	150	160	159	159	175
Indonesia	1,189	1,423	1,193	1,238	1,190	1,138
Iran	2,300	2,174	2,317	1,848	2,369	2,240
Iraq	1,200	1,210	1,780	1,690	1,540	2,688
Kuwait	900	945	999	1,244	996	1,335
Libya	990	1,091	999	1,031	996	1,025
Neutral Zone	†	439	†	343	†	313
Nigeria	1,300	1,414	1,304	1,465	1,301	1,390
Qatar	280	396	300	332	299	346
Saudi Arabia	4,353	4,464	4,353	4,837	4,343	4,946
United Arab Emirates	950	1,159	950	1,330	948	1,474
Venezuela	1,555	1,711	1,574	1,642	1,571	1,649
Total	**16,000**	**17,442**	**16,819**	**18,074**	**16,600**	**19,665**

*Production quotas did not apply for full year. †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia.

Source: OPEC and Author's estimates

WORLDWIDE GAS RESERVES

	Jan. 1 (Billion cu ft)						
	1973	1978	1983	1988	1989	Change 1989-1973	% change 1989/1973
Australia	36,236	32,000	17,768	18,610	16,633	−19,603	−54.1
India	2,300	3,500	14,508	17,550	22,861	+20,561	+894.0
Indonesia	5,500	24,000	29,600	73,000	83,590	+78,090	+1,419.8
Malaysia	*10,000	17,000	34,000	52,200	51,700	+41,700	+417.0
Pakistan	16,000	15,500	18,540	22,400	17,722	+1,722	+10.8
Thailand	—	4,500	11,000	3,720	3,885	+3,885	—
Others	31,200	31,225	20,831	37,320	44,259	+13,059	+41.9
Total Asia-Pacific	**101,236**	**122,725**	**146,247**	**224,800**	**240,650**	**+139,414**	**+137.7**
Netherlands	88,000	60,000	51,920	64,100	62,507	−25,493	−29.0
Norway	15,000	20,000	58,000	105,940	85,500	+70,500	+470
United Kingdom	45,000	29,000	25,400	22,000	22,740	−22,260	−49.5
Others	30,400	29,190	21,416	26,140	29,370	−1,030	−3.4
Total Western Europe	**178,400**	**138,190**	**156,736**	**218,180**	**200,117**	**+21,717**	**+12.2**
Abu Dhabi	12,000	20,000	19,260	183,500	183,500	+171,500	+1,429.2
Iran	200,000	500,000	482,600	489,400	494,400	+294,400	+147.2
Iraq	25,000	28,000	28,800	26,300	95,000	+70,000	+280.0
Kuwait	33,000	31,500	29,900	36,400	42,500	+9,500	+28.8
Qatar	8,000	40,000	62,000	156,700	156,700	+148,700	+1858.8
Saudi Arabia	50,000	85,000	117,000	139,900	145,848	+95,848	+191.7
Others	16,150	15,160	30,170	51,830	64,175	+48,025	+297.4
Total Middle East	**344,150**	**719,660**	**769,730**	**1,084,030**	**1,182,123**	**+837,973**	**+243.5**
Algeria	105,000	125,000	111,250	105,900	104,200	−800	−0.8
Libya	27,500	25,700	21,500	25,700	25,700	−1,800	−6.5
Nigeria	40,000	43,000	32,400	84,000	85,000	+45,000	+112.5
Others	16,515	13,804	24,273	33,030	38,410	+21,895	+132.6
Total Africa	**189,015**	**207,504**	**189,423**	**248,630**	**253,310**	**+64,295**	**+34.0**
Argentina	8,800	8,120	25,200	23,600	26,700	+17,900	+203.4
Mexico	11,500	30,000	75,850	76,530	74,831	+63,331	+550.7
Trinidad & Tobago	7,500	8,500	11,000	10,390	10,500	+3,000	+40.0
Venezuela	34,600	41,000	54,079	95,000	102,243	+67,643	+195.5
United States	271,455	210,000	204,000	186,700	187,200	−84,255	−31.0
Canada	55,000	58,000	97,000	98,000	95,100	+40,100	+72.9
Others	16,818	20,960	20,462	21,140	21,867	+5,049	+30.0
Total Western Hemisphere	**405,673**	**376,580**	**487,591**	**511,360**	**518,441**	**+112,768**	**+27.8**
Total Non-Communist	**1,218,474**	**1,564,659**	**1,749,727**	**2,287,000**	**2,394,641**	**+1,176,167**	**+96.5**
U.S.S.R.	635,400	920,000	1,240,000	1,450,000	1,500,000	+864,600	+136.1
Others	29,000	35,000	43,800	60,000	60,700	+31,700	+109.3
Total Communist	**664,400**	**955,000**	**1,283,800**	**1,510,000**	**1,560,700**	**+896,300**	**+134.9**
Total World	**1,882,874**	**2,519,659**	**3,023,527**	**3,797,000**	**3,955,341**	**+2,072,467**	**+110.1**
Total OPEC	**561,600**	**980,150**	**1,018,564**	**1,452,720**	**1,468,616**	**+907,016**	**+161.5**
OPEC as % of World	29.8%	38.9%	33.7%	38.3%	37.1%	—	—

*Includes Brunei

Source: Oil & Gas Journal

This may really be one of the major issues of concern to the world oil industry in the future. The major international oil companies have lost control over a substantial portion of world crude production. Now they will be meeting competition from OPEC in refining. This is probably also of concern to the major industrial countries. A great deal of revenue is derived from taxes on refined products. If OPEC is able to capture a portion of the refined product market, they may capture the revenue now collected as taxes by the industrial countries, or substantially drive up the prices of refined products.

Several of the major OPEC producing countries have also adopted a new strategy. Venezuela, Kuwait and Saudi Arabia have made substantial investments in downstream refining and marketing facilities in the industrial countries. They appear to be trying to establish major fully-integrated operations in these areas, similar to the major international oil companies. They are seeking secure markets for their crude and also trying to capture some of the profit from these downstream activities.

Refiners also play a major role in the maintenance of crude and petroleum product stock levels. And stock levels play a major role in determining short run and seasonal swings in crude demand and prices.

When the turn around started, in 1980 and 1981, the reluctance of refiners to adjust immediately to the initial drop in demand, coupled with a reluctance to break long-term contractual agreements for crude from export nations, resulted in a huge buildup of stocks. Stocks for the OECD group of countries increased 465 million bbl from 1978 to 1980, and peaked at 3,587 million bbl in 1980.

Refiners originally defended the high stock levels as a buffer against a potential supply disruption and a rebound in demand. But the acceleration in worldwide inflation brought high interest rates that translated into very high carrying costs for the excessive inventories. With depressed margins and sharply reduced profits it was essential that action be taken to reduce these costs.

Refiners found it difficult to reduce stocks in the face of falling demand, but they made a concentrated effort by breaking long-term crude supply agreements. This in effect forced stocks back into the ground by reducing offtakes from the producing countries. From 1980 to 1985, stocks of the OECD countries were reduced 301 million bbl. These were all private stocks in the hands of refiners, and marketers. Public/government stocks such as the U.S. Strategic Petroleum Reserve continued to be increased however. Those stocks represent a government financed buffer to protect against supply disruptions.

With increased demand and the continued build up in government stocks, total stocks moved up in 1986 and 1987. Stocks remained at about the same level in 1988. Part of this build up is also due to the lower crude prices. It is not as costly at present for refiners to hold stocks as a contingency. It appears that refiners have reached an acceptable balance between demand and stocks and therefore have stopped their inventory drawdown. And with demand on the rise, refiners are adding to stocks to maintain this balance. Refiners have to keep a minimum level of stocks in order to operate efficiently.

Sharp fluctuations in price can cause refiners to moderate this operating philosophy. When prices drop they generally build inventories to take advantage of the low cost crude. And if prices move up rapidly, there is a tendency for refiners to reduce inventories and minimize costs.

NATURAL GAS. Oil is only one of several major energy sources. This must be taken into consideration when analyzing the need for oil. Over the past 10 years, the level of worldwide oil production has been influenced primarily by the price of oil, but competition from competing fuels has also been a factor.

One of the major competing fuels has been natural gas. And natural gas is growing in importance as a fuel throughout the world.

Total world production in 1988 was 68.037 trillion cubic feet. This was up 4.1% from 1987 and up 38.4% from 1978. Non- communist area production was 37.9 trillion cubic feet in 1988. This was up 12.1% from 1978. The communist countries posted the greatest increase over the ten years 1978–1988. Production was up 96.4%, to 30.137 trillion cubic feet in 1988. This was an increase of 14.79 trillion cubic feet, primarily due to the increased production of the U.S.S.R.

Production in the U.S.S.R. moved up 113.9% over the ten year span, to 27.193 trillion cubic feet in 1988. The U.S.S.R. passed the U.S. in 1983 to become the world's largest natural gas producing country.

All of this production is not consumed in the U.S.S.R. or in Eastern Europe. The U.S.S.R. has recently been exporting large volumes of gas to Western Europe. They have been concentrating a lot of resources on developing natural gas. In addition to exports they have adopted a policy of transforming segments of their economy from oil consuming to natural gas. This enables them to export greater volumes of crude oil, and obtain hard currency for foreign trade. Their plentiful reserves enable them to pursue both of these objectives.

North America and Western Europe were the only major geographic area where natural gas production was lower in 1988 than 1978. North American production was down 9.2% over this period. The decline was due to a 12.7% reduction in U.S. output. Canadian production was up 15.3% over 1978.

Production in Western Europe was down due to a sharp drop in Netherlands output in 1988. In all other areas production was up: +186.1% in Africa, +179.1% in Asia and Australasia, +62.4% in Latin America, and +54% in the Middle East.

The natural gas share of worldwide total primary energy consumption moved up from 18.2% in 1975 to 20.1% in 1985. It fell slightly to 19.9% in 1986, then moved up to 20% in 1987 and 20.2% in 1988. In the non-communist countries, natural gas lost some of its market share dropping from 19.2% in 1975 to 18.9% in 1985 and 18.1% in 1986. This was primarily due to a drop in U.S. natural gas production and consumption. In 1987, the market share moved up to 18.1%. It remained at 18.1% in 1988. In 1988 total consumption increased another 4%. It was up in all areas except Western Europe.

Although there has been no dramatic shift to natural gas, there have been some indications that demand may increase sharply in the future. It is a clean burning fuel that does not pollute and is therefore looked upon favorably by those concerned with the environment. And concern for the environment is growing throughout the world.

The biggest hurdle to jump, if consumption is going to rise, is the high cost of transporting natural gas from the areas with large reserves to the industrial consuming areas. Natural gas is most efficiently transported by pipelines, but long pipelines are very expensive. It can be liquefied and shipped by tanker but this is also extremely expensive.

As with oil, natural gas reserves are distributed disproportionately with reserves concentrated in a few countries. The U.S.S.R. has by far the largest reserves with 1,500 trillion cubic feet, 37.9% of the world total, as of January 1, 1989. At their present rate of production, they have a 58.6 year supply.

Iran has the second largest level of reserves, with 494.4 trillion cubic feet, 12.5% of total world reserves. Together, Iran and the U.S.S.R. have over 50% of total world reserves.

At the present time, non-communist reserves are about 2,395 trillion cubic feet. This includes the Iranian reserves. At the 1988 rate of production this represents a 63.2 year supply. But a substantial proportion of those reserves are in countries far from the areas of consumption. This will make it very expensive to utilize these reserves.

U.S. reserves are only 4.7% of the total world reserves and only 7.8% of non-communist reserves. And the reserves to production ratio indicates only a 11.2 year supply at the 1988 rate of production.

NET BACK PRICING EXAMPLE

	$/barrel
Product revenues	18.50
Less: refining costs	2.50
Less: processing/handling fee	2.00
Less: transport cost	1.50
Net back price of crude*	**12.50**

*The net back value varies depending on product revenues and costs

OUTLOOK

The OPEC level of production, the price level, politics and demand for petroleum products will all play a role in determining the outlook on the supply side of the worldwide oil industry. The price level will be greatly influenced by the level of OPEC production. And the OPEC production level will in turn be influenced by OPEC politics and individual OPEC country economics.

OPEC will have the greatest influence, but there are other factors that will also dictate the supply side of the industry outlook. The total supply of crude that is made available in the non-OPEC areas will be determined primarily by the price level. But in the non-OPEC areas there are other factors that are now exerting a great deal of influence. The natural decline rate is beginning to take hold in some of the major non-OPEC producing areas. The

VALUE—OPEC PETROLEUM EXPORTS

Year	Crude exports	Product exports (1,000 b/d)	Total exports	Value of exports ($ million)	Average value ($/bbl)
1980	22,843.7	2,011.1	24,854.8	286,984	31.55
1981	18,424.0	1,980.6	20,404.6	265,146	35.60
1982	14,235.2	2,276.3	16,511.5	206,655	34.29
1983	12,485.6	2,045.8	14,531.4	161,260	30.40
1984	11,983.0	2,290.9	14,273.9	148,473	28.42
1985	10,810.5	2,457.0	13,267.5	130,681	26.99
1986	12,779.6	2,730.7	15,510.3	78,834	13.93
1987	12,013.4	2,917.8	14,931.2	95,699	17.56
Average	**14,446.9**	**2,338.8**	**16,785.7**	**171,717**	**28.03**

Source: OPEC Statistical Bulletin

Alaskan North Slope and some of the North Sea fields are prime examples of fields with peaking production and expectations of long run future decline.

The outlook for worldwide supply was altered dramatically when prices dropped sharply in 1986. The cyclical fluctuation of prices and the repeated weakness in prices over the past four years have reduced investment in production. Both the level of production and the geographic pattern of supply have been altered by the repeated price corrections. Even though prices have rebounded in 1987 and 1989, they did not return to the pre-1986 levels. With prices slipping repeatedly, it appears that the industry is caught in an era of frequent periods of lower than anticipated crude prices.

During the last few years the level of production has been oscillating with the level of prices. Production moved up in 1986 with the precipitous drop in prices. Output slipped in 1987 when prices rebounded, and then production moved up again in 1988 as prices slipped. The relatively low level of prices since 1986 has helped stimulate demand for petroleum products. This has helped boost output in 1989 even though prices were up from the previous year. The rebound in prices in 1989 was more gradual and the price hike was not as great as in 1987.

The huge overhanging excess capacity continues to put substantial downward economic pressure on prices. The only way that this pressure can be counteracted in the short run is if substantial production capacity is shut-in. If sufficient capacity was shut-in, the pressure on prices could be reversed and crude prices could be raised and/or supported at a higher level. The only producing entity that has the ability to curtail sufficient capacity to influence the price level is OPEC. So the price level over the forecast period will be almost solely dependent upon OPEC's willingness to rein in production. And that is dependent upon the political/economic situation in the individual OPEC countries.

Upward pressure on prices could also emerge if there were a substantial increase in demand. This would also reduce the excess capacity. But in the highly competitive energy market, a large increase in demand can only be achieved at relatively low prices. Competitive prices that would prevent switching to alternative fuels such as natural gas or coal. Economic growth is generally relatively modest so that any increase in demand will only be realized over an extended period of time.

Therefore, any immediate extended increase in prices can only be achieved if OPEC establishes and adheres to a quota that comes close to balancing supply and demand.

Without significant upward "economic pressure", prices are projected to move up gradually and modestly over the forecast period, 1990–1994. It is expected that the relatively low existing and future price level will stimulate demand over the forecast period. But this in turn will therefore generate a modest amount of upward economic pressure. And it is also expected that OPEC periodically will show some level of discipline, curtailing production from time to time. This will put some additional upward pressure on prices.

Prices over the forecast period will move up from a somewhat higher 1989 base. Prices in 1989 were up 18.9% from the low 1988 level. The increase over the entire forecast period will be what appears to be fairly substantial, +33.8%. But the average price for world export crude will only reach $21.95/bbl in 1994.

It is expected that prices will remain relatively weak in 1990. Increased non-OPEC output and only a modest increase in demand will keep downward pressure on prices. Prices are expected to slip slightly to $16.25/bbl in 1990. This assumes that OPEC shows some production discipline and does not flood the market with crude oil. After that, from 1991 through 1994, prices will move up more rapidly, and faster than inflation.

By the end of the forecast period, OPEC production will have increased substantially and reduced the excess capacity. OPEC will be in a position which might enable them the group to boost prices substantially.

At that time the price level will be more dependent upon the objectives of Saudi Arabia and the group of OPEC countries with huge reserves. If Saudi Arabia decides to meet the rising demand by increasing output and capacity they can maintain control over prices. With their substantial reserves it would appear to be in Saudi Arabia's best interests to keep modest and prevent them from increasing rapidly. It would appear to be in their long range best interests to keep prices at a level that will stimulate demand and discourage investment in competing oil and energy sources.

The lower level of prices is expected to stimulate demand for petroleum production and therefore crude oil production throughout the forecast period 1990 to 1994. Current dollar prices are not expected to get back up to the pre-1986 level throughout the forecast period. And although real prices are expected to move up, they will still be substantially lower than the 1979–1985 period.

Total world production is forecast to move up 8.2% over the forecast period, up 5.19 million b/d to 68.58 million b/d. Non-communist production is projected to move up even faster increasing 8.7% over the next five years to 51.89 million b/d in 1994.

This relatively lower level of oil prices will have a negative impact on exploration and development in the higher cost non-OPEC areas. Non-OPEC area production is expected to peak in 1991 as North Sea and Alaskan production both peak and begin to slide. Non-OPEC production is expected to drop slowly over the remainder of the forecast period, dropping back to 25.7 million b/d in 1994.

Increasing demand for crude oil and falling non-OPEC production will result in increased demand for OPEC oil to fill the gap. OPEC production will move up steadily over the forecast period. OPEC production will move up 3.552 million b/d, 15.7%, to 26.19 million b/d in 1994. By 1992 a lot of the OPEC excess capacity will be eliminated. At that time OPEC may be in a position to put some upward pressure on prices. By the end of the forecast period OPEC output will have climbed to 50.5% of non-communist production and 38.2% of total world production.

The exploration effort is expected to follow crude oil prices throughout the forecast period. The active international rig count (outside the U.S. and Canada) bottomed out in 1987 at 981 rigs. As prices move up and demand for oil moves up over the forecast period the rig count is projected to increase. The rig count is forecast to move up 11.4% to 1030 average rigs in 1994.

Refining capacity in the non-communist areas is sufficient to handle the expected increase in demand, but a modest increase is expected as demand moves up. A higher utilization rate is more profitable for the industry so capacity will not move up as fast as demand. Total non-communist worldwide refining capacity is expected to move up marginally over the forecast period. Total capacity is expected to increase 2%, 1.1 million b/d, to 57.5 million b/d in 1994.

In the industrial countries refining capacity is still being adjusted to the lower level of petroleum product demand that was a result of the price shocks. Refining profitability is substantially affected by the utilization rate. Refiners strive for a utilization rate of over 80% in order to achieve adequate margins.

Although capacity will remain relatively constant over the forecast period, crude runs to refineries will move up with demand. Crude runs will increase 8.5% to 48.36 million b/d in 1994. As a result, the overall average utilization rate will move up steadily from 79% in 1989 to 84.1% in 1994.

There is a possibility that some industrial countries may consider an adequate level of refining capacity as a national security objective. If that proves to be the case, there may be some additional increase in refining capacity over the forecast period. But it is doubtful that there would be a significant additional increase.

There is not expected to be any major geographical shift in natural gas production over the forecast period. The U.S.S.R. is expected to continue to develop their vast reserves, and they are expected to continue to supply European energy needs.

Natural gas resource development is expected to continue to expand over the 1990–1994 period. But the area with the largest reserves, the Middle East, is politically unsettled and a long distance from the larger consuming areas. Therefore, any increase in reserves or output in this area is not expected to be major or to have a major impact on world energy needs. However, increased natural gas development for internal con-

THE OUTLOOK — WORLDWIDE SUPPLY

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
WORLD OIL PRODUCTION									
(Total liquids—thousand barrels/day)									
OPEC production	21,145	22,638	22,440	23,140	24,485	25,515	26,190	+3,552	+15.7
Non-OPEC production	25,175	25,077	25,900	26,000	25,900	25,800	25,700	+623	+2.5
Total Non-Communist	**46,320**	**47,715**	**48,340**	**49,140**	**50,385**	**51,315**	**51,890**	**+4,175**	**+8.7**
Communist	15,875	15,675	15,890	16,040	16,190	16,285	16,690	+1,015	+6.5
Total world production	**62,195**	**63,390**	**64,230**	**65,180**	**66,575**	**67,600**	**68,580**	**+5,190**	**+8.2**
WORLD REFINING									
Non-Communist (thousand barrels/day)									
Capacity	56,325	56,400	56,600	56,800	57,150	57,350	57,500	+1,100	+2.0
Crude runs	43,555	44,580	45,340	45,975	46,940	47,640	48,360	+3,780	+8.5
Utilization rate (%)	77.3	79.0	80.1	80.9	82.1	83.1	84.1	+5.1	+6.5
World active drilling rigs									
Non-communist									
Outside U.S. & Canada	1,023	925	940	960	985	1,010	1,030	+105	+11.4
Canada	196	126	135	145	155	165	175	+49	+38.9
U.S.	936	854	930	980	1,030	1,080	1,130	+276	+32.3
Total	**2,155**	**1,905**	**2,005**	**2,085**	**2,170**	**2,255**	**2,335**	**+430**	**+22.6**
Crude oil price Average world export price ($/barrel)	13.79	16.40	16.25	17.25	19.25	20.85	21.95	+5.55	+33.8

sumption in this area would release additional crude for export. That would reduce the upward pressure on prices resulting from increased crude oil demand.

WORLDWIDE SUPPLY—KEYS TO THE FUTURE

1. The large level of excess production capacity will put downward pressure on prices throughout the forecast period. Coupled with lapses in OPEC production discipline, this will keep crude prices well below the 1980–1985 levels throughout the forecast period.

2. Relatively low prices and economic growth will stimulate demand for petroleum products and crude oil throughout the forecast period. Worldwide production will move up along with demand.

3. OPEC's ability to set a realistic production quota and adhere to it will play a major role in determine the price level throughout the forecast period. Led by Saudi Arabia, it is expected that OPEC will show some discipline and have periodic success in supporting the desired price level.

4. Non-OPEC production will begin to slide during the forecast period. Several major producing areas will peak and begin a natural decline. OPEC output will move up to fill the gap between increasing demand and falling non-OPEC output. This will reduce the level of excess capacity.

5. During the latter half of the forecast period the pressure from excess capacity will diminish. Prices will begin to move up. This will stimulate a modest increase in exploration activity.

6. Refining capacity will be increased marginally as demand moves up. Crude throughput will move up along with demand. The refinery utilization rate will increase throughout the forecast period.

U.S. OUTLOOK— DEMAND

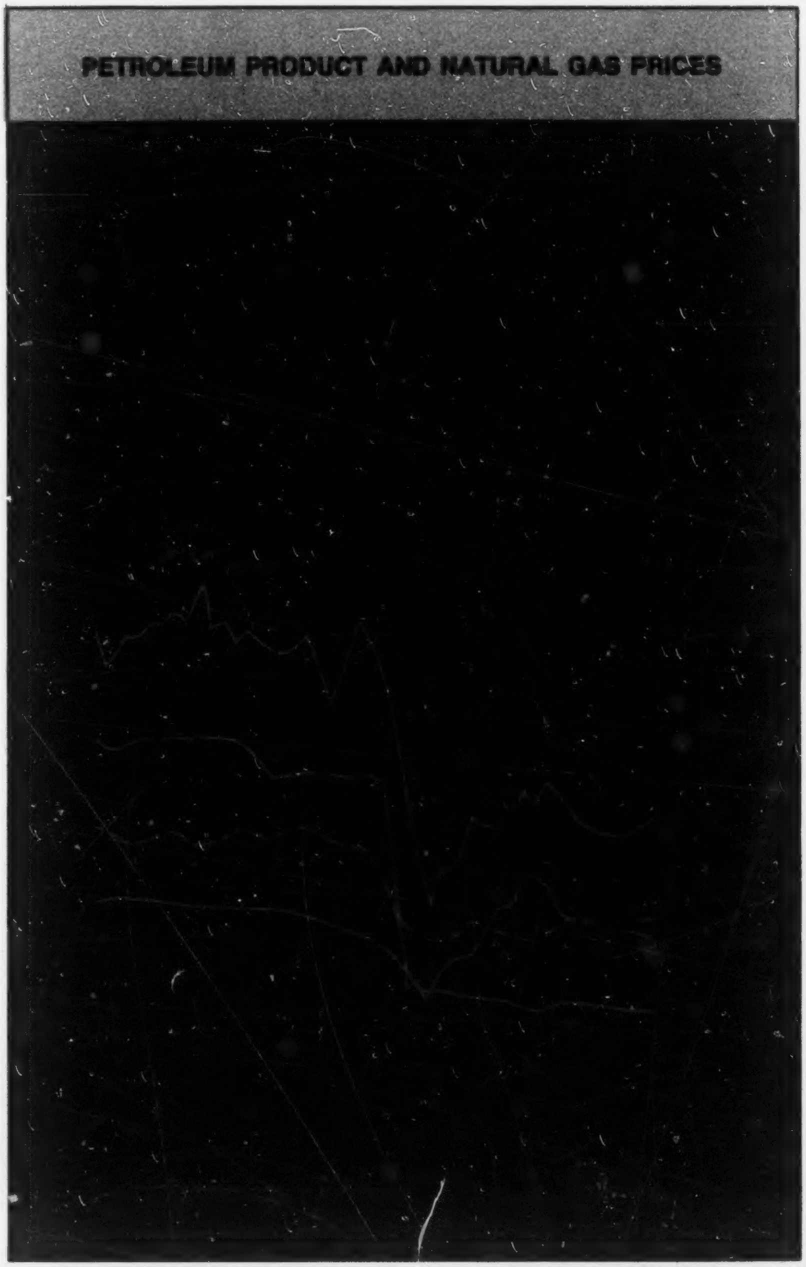
■

Domestic U.S. demand for petroleum products has been on the rise since 1983. The lower level of crude oil and product prices has stimulated consumption. The lower oil prices that have prevailed since 1986 have had a substantial impact on the demand for petroleum products in the U.S. The sharp drop in prices in 1986 stimulated demand and brought about the largest year to year increase in consumption of petroleum products since 1977. Although not quite as large, a substantial increase in consumption was also posted in 1987. The sharp drop in prices in 1988 repeated this cycle and demand moved up even more than in 1986.

Demand has exhibited a close relationship to the price level over the past decade. This has dispelled the theory that oil demand was impervious to the price, or that in economic terms, it was totally inelastic.

After decades of steadily increasing oil demand, it was stopped in its tracks in 1978 and reversed by rapidly escalating oil prices. This was after an almost unbroken string of annual increases in consumption dating back to the 1920's.

It took some time for the fact to sink in that oil demand does respond to prices. The price changes have to be major in order to make a significant


PETROLEUM PRODUCT AND NATURAL GAS PRICES

impact on the level of demand. But it did become apparent that a great deal more attention will have to be paid to the relationship between oil demand and price in all future analysis and projections.

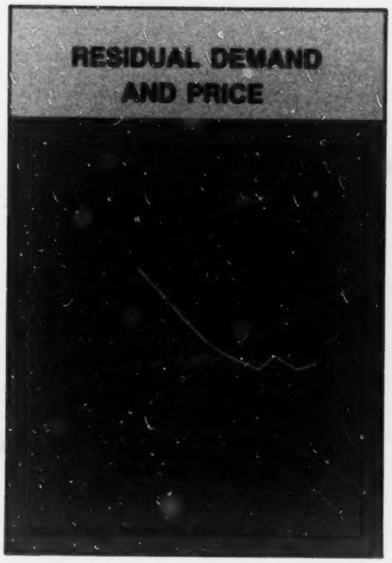
However, it isn't only the price of oil that has to be considered in any projection, it is also the cost of competing energy sources. Rising energy costs in the 1970's and early 1980's led to conservation and to fuel switching and multiple fuel capabilities. As energy costs rose it became apparent to large energy consumers that the most cost effective way to meet their energy needs was through the investment in multiple fuel capacity and conservation. With fuel switching capability they could easily switch their consumption to the lowest cost fuel available. This substantially increased the competition between fuels. And as a result, the prices of competing fuels tend to closely track each other.

However, substantial differences can arise when there are significant changes in fuel supply markets. As competing fuels adjust prices to obtain a competitive advantage or in reaction to shifts in raw material costs, the swings in demand can be substantial. This happened in 1986 with respect to petroleum products. The precipitous drop in prices enabled petroleum to recapture a portion of some fuel markets it had lost in earlier years.

An additional factor that has an impact on demand for petroleum or energy in general is the level of the conservation effort. At lower prices the incentive to invest in conservation capital equipment or fuel switching capital equipment is substantially diminished. And the discretionary conservation exhibited by consumers under higher prices is also greatly reduced. The discretionary conservation of individual consumers had a large impact on the level of consumption of motor gasoline and fuel oils for home heating and cooling.

All of these factors have contributed to the increased consumption of petroleum products over the past several years. Petroleum has regained some of its competitive advantages as a fuel, and the conservation incentive has been reduced.

The size of the U.S. oil industry in terms of revenue and investment



RESIDUAL DEMAND AND PRICE

DISTILLATE FUEL OIL DEMAND AND PRICE

PRICES* OF FOSSIL FUELS USED IN ELECTRIC GENERATION

	Coal	Residual oil	Natural gas	All fossil fuels	Residual oil price as % of Coal	Residual oil price as % of Natural gas
	(¢/MMBTU)					
1974	70.9	189.0	48.2	91.4	266.6	392.1
1975	81.4	200.5	75.2	104.4	246.3	266.6
1976	84.8	195.2	103.4	111.9	230.2	188.8
1977	94.7	219.8	129.1	129.7	232.1	170.3
1978	111.6	212.5	142.2	141.1	190.4	149.4
1979	122.4	298.8	174.9	163.9	244.1	170.8
1980	135.1	426.7	219.9	192.8	315.8	194.0
1981	153.2	533.4	280.5	225.6	348.2	190.2
1982	164.7	483.2	337.6	224.9	293.4	143.1
1983	165.6	457.8	347.4	220.6	276.4	131.8
1984	166.4	481.2	358.3	219.2	289.2	134.3
1985	164.8	424.4	343.1	209.6	257.5	123.7
1986	157.9	240.1	234.4	175.0	152.1	102.4
1987	150.6	297.6	223.5	170.7	197.6	133.2
1988	146.7	240.3	226.5	164.5	163.8	106.1

*Delivered price to steam-electric utility plants.

Source: Energy Information Administration

has diminished over the past few years. But it should be remembered that the U.S. economy is still driven to a large extent by the consumption of petroleum and natural gas. These two fuels still provide almost two-thirds of U.S. energy. And their significance will be only marginally reduced over the forecast period. What happens in the oil and gas industry over the next five years is an important part of what happens to the U.S. economy.

REVIEW

ENERGY DEMAND. The level of economic growth or activity is the major determinant of the demand for energy. The type of economic activity also plays a role in determining the level of energy demand. However, it has become evident, particularly in recent years, that the level of energy demand is also closely related to the cost of energy. The degree of energy conservation and degree of efficiency desired is dependent upon the cost of energy relative to other costs of production and goods.

The demand for crude oil, petroleum products and natural gas in the U.S. is related to all of the factors mentioned above, i.e., economic activity, overall energy demand and the cost of energy. Therefore, it is worthwhile to have an understanding of the past trends and relationships among these factors before determining the level of petroleum demand.

Since 1973, the U.S. economy has gone through two recessions. Both followed major increases in oil prices and in energy costs in general. One recession was in 1974–1975 when real Gross National Product (GNP), expressed in 1982 dollars, fell 1.8% over 2 years. The second occurred in 1982, when real GNP fell 2.5%. Between 1978 and 1982 the economy was almost at a stand still with growth of only 1.6%. The U.S. economy began pulling out of the most recent recession during 1983. Real GNP moved up 3.5% in 1983. The pace of economic growth accelerated in 1984 with real GNP increasing 6.4%. Since then the economy has been growing at a modest but steady pace: 3.4% in

1985, 2.7% in 1986, 3.7% in 1987, 4.4% in 1988 and an estimated 2.3% in 1989.

The lock-step relationship between economic growth and energy demand in the U.S. was broken in 1970. From 1950 through 1970, real GNP increased 100.2%. Over the same period, energy consumption increased 97.5%. The amount of energy consumed per real dollar of GNP fell only slightly, from 28,200 BTU per dollar of GNP in 1950 to 27,800 BTU in 1970. Economic growth during that period was being fueled by cheap energy. Growth was primarily in the industrial sector, which was relatively energy intensive. With energy quite inexpensive there was little if any incentive for energy conservation. So energy consumption grew as fast as economic output.

This changed markedly in the 1970's when the cost of energy began to increase. From 1970 through 1988, GNP increased 66.6%, but energy consumption moved up only 19.3%. Over that 18 year period, the growth of energy and GNP moved from a one-to-one relationship to a 0.29-to-one relationship; meaning that energy consumption increased only 2.9% for every 10% increase in economic activity. This was a dramatic shift from the previous 20 years. And the energy consumption has gone up faster in the past few years. This ratio was much lower for the period 1970-1984.

Total energy consumption per GNP dollar fell for eighteen consecutive years, from 27.8 thousand BTU in 1970 to 19.9 thousand in 1988. Over those eighteen years there was a 28.4% improvement in the efficiency of energy consumed.

The rapid increase in the price of energy in the 1970's was a major reason for the improvement in energy efficiency. The rising cost of energy relative to other factors of production provided a cost-cutting and profit incentive for minimizing energy requirements.

The oil price hikes of 1973–1974 and 1979–1981 rapidly boosted the cost of petroleum products and the cost of energy in general. This had the effect of providing additional incentive for conservation and accelerated the drop in energy use per dollar of GNP.

Following the 1973–1974 price hike, the economy went into a recession, with real GNP falling in 1974 and 1975. Energy consumption fell from 74,282 trillion BTU in 1973 to 70,546 trillion BTU in 1975, a decline of 5%. Following the 1979-1981 price hike, the economy again went into a recession in 1982. Due to the price-induced conservation, energy consumption actually started falling in 1980, and the fall accelerated with the drop in economic activity. Energy consumption fell for four consecutive years, dropping 10.7% from 78,898 trillion BTU in 1979 to 70,497 trillion BTU in 1983.

Since 1981 oil prices have been falling and other energy costs have also dropped. This has moderated the incentive for conservation. During 1984, real GNP increased 6.8% and energy consumption moved up 5.1%. This is a ratio of 0.75 to 1, and is a sharp increase in relative energy consumption. But conservation has not stopped completely. In 1985, GNP increased 3.4% while energy consumption fell 0.2%. In 1986 GNP increased 2.7% while energy consumption only moved up 0.4%. In 1987 GNP was up 3.7% and energy consumption up 3.4%. And in 1988 GNP increased 4.4% and energy consumption also moved up 4.4%. Energy conservation continues but the incentive has been muted.

The consumption of petroleum energy per dollar of real GNP also fell after the second oil price hike in 1979. Petroleum energy consumed per dollar of GNP fell from 12.5 thousand BTU in 1977 to 8.6 thousand BTU in 1985. In 1986 it moved up to 8.7 thousand BTU as oil demand increased at a rate higher than GNP. But it fell again in 1987 to 8.5 thousand BTU per dollar of GNP. And it remained at that level in 1988.

A substantial part of the more efficient use of energy has been due to price-induced conservation following the rapid and sharp increase in energy costs. But the shift in the profile of the economy has also been an important factor. The U.S. is moving from a principally industrial economy to a more service and information oriented economy. The service and information types of economic activity are far less energy intensive than industrial activity.

It should also be pointed out that the response to price increases can be spread out over an extended period. It can be rapid in the transportation sector, but is generally much slower in the residential/commercial, utility and industrial sectors. In those latter sectors, adjustment can extend over 5 to 10 or more years. A major portion of this type of demand adjustment is permanent, since it is due to investment in improved capital goods.

In the U.S. there has been a shift in energy consumption, away from the industrial sector to the residential/commercial and transportation sectors. Consumption in

FACTORS DETERMINING MOTOR GASOLINE DEMAND

	Total vehicle registrations* (1,000)	Total vehicle miles of travel (Billion)	Car registrations (1,000)	Average age of cars	Fuel consumed per car (Gallons)	Miles traveled per car	Miles per gallon
1970	108,418	1,109.7	89,244	5.6	760	10,272	13.52
1975	132,949	1,327.7	106,706	6.0	716	9,690	13.52
1980	155,796	1,527.3	121,601	6.6	591	9,141	15.46
1982	159,643	1,592.5	123,702	7.2	566	9,428	16.65
1984	166,249	1,720.3	128,158	7.5	536	9,558	17.83
1985	171,654	1,774.2	131,864	7.6	525	9,560	18.20
1986	176,191	1,834.9	135,431	7.6	526	9,608	18.32
1987	179,044	1,924.3	137,324	7.6	515	9,883	19.17

*Excludes military vehicles.

Source: Motor Vehicle Manufacturers Assoc. Facts & Figures Report 1989, EIA

CRUDE OIL PRICES

	Saudi Light (Jan.1)	U.S. average wellhead	— Refiners' acquisition cost — Domestic	Imported	Composite
	(Dollars per barrel)				
1970	1.35	3.18	3.46	2.96	3.40
1971	1.75	3.39	3.68	3.17	3.60
1972	1.90	3.39	3.67	3.22	3.58
1973	2.10	3.89	4.17	4.08	4.15
1974	10.84	6.87	7.18	12.52	9.07
1975	10.46	7.67	8.39	13.93	10.38
1976	11.51	8.19	8.84	13.48	10.89
1977	12.09	8.57	9.55	14.53	11.96
1978	12.70	9.00	10.61	14.57	12.46
1979	13.34	12.64	14.27	21.67	17.72
1980	26.00	21.59	24.23	33.89	28.07
1981	32.00	31.77	34.33	37.05	35.24
1982	34.00	28.52	31.22	33.55	31.87
1983	34.00	26.19	28.87	29.30	28.99
1984	29.00	25.88	28.53	28.88	28.63
1985	29.00	24.09	26.66	26.99	26.75
1986	28.00	12.51	14.82	14.00	14.55
1987	16.15	15.40	17.76	18.13	17.90
1988	17.52	12.57	14.76	14.64	14.71
Change 1981-1988	−14.48	−19.20	−19.57	−22.41	−20.53
% change 1981-1988	−45.3%	−60.4%	−57.0%	−60.5%	−58.3%
Change 1970-1988	16.17	9.39	11.30	11.68	11.31
% change 1970-1988	1,197.8%	295.3%	326.6%	394.6%	332.6%

Source: Energy Information Administration

the industrial sector dropped from 31.54 quads in 1973 to 25.75 quads in 1983, a drop of 18.4%. The industrial sector share of total energy consumption dropped from 42.5% to 36.5%. This reflects conservation and more efficient use of energy in the industrial sector, as well as the diminishing importance of the industrial sector in the total economy.

There was a rebound in energy consumption by the industrial sector in 1984. Energy consumption in this sector moved up 7.7% to 27.74 quads, 37.4% of total energy. One of the major reasons for the surge in energy consumption in 1984 was the economic improvement in the more energy intensive industrial sector.

Industrial consumption of energy slipped a bit in 1985 to 27.08 quads, 36.6% of the total energy consumed. It slipped again in 1986 to 26.45 quads down 2.3%. This was 35.6% of total energy consumed. There was a rebound to 27.65 quads in 1987, up 4.5%. This was 36% of total energy consumed. Industrial energy consumed moved up another 5.4% in 1988 to 29.14 quads. This was 36.4% of total energy. Expectations are that the relative importance of the industrial sector will continue to slide, but the recent upturn in economic activity and industrial output has slowed the slide.

Residential/commercial sector energy consumption has increased from 24.14 quads in 1973 to 29.1 quads in 1988, an increase of 20.6%. This sector's share of the total market increased from 32.5% to 36.3%. The growth in this sector of the economy has more than offset the improvement in energy efficiency and conservation. Growth in this sector is expected to be slow but steady over the forecast period, reflecting the shift to a more service and information oriented economy.

Consumption of energy in the transportation sector has also increased over this period, moving up 17.7% from 18.60 quads in 1973 to 21.90 quads in 1988. The share of total energy consumption increased from 25% to 27.3%. Although there has been continued improvement in vehicle fuel efficiency, the total vehicle fleet has been increasing along with the population. And as gasoline and diesel fuel prices have leveled off during the past few years, there has been less incentive for discretionary conservation. Energy consumption in this sector was up 14.5% over the five years, 1983–1988.

There has not only been a shift in the end use of energy, but also a shift in the source of energy. Over the past 15 years, coal and nuclear energy have been increasing their share of the energy market, while petroleum and natural gas have been declining.

REFINED PETROLEUM PRODUCTS SUPPLIED BY TYPE

(Million b/d)

	Motor gasoline	% of total	Jet fuel	% of total	Distillate fuel oil	% of total	Residual fuel oil	% of total	Ethane and liquefied gases	% of total	Other products	% of total	Total products	% of total	% change from previous year
1974	6.54	39.3	0.99	5.9	2.95	17.7	2.64	15.8	1.41	8.5	2.12	12.8	16.65	100.0	−3.8
1975	6.68	40.9	1.00	6.1	2.85	17.5	2.46	15.1	1.33	8.1	2.01	12.3	16.32	100.0	−2.0
1976	6.98	40.0	0.99	5.6	3.13	17.9	2.80	16.0	1.40	8.1	2.16	12.4	17.46	100.0	7.0
1977	7.18	38.9	1.04	5.6	3.35	18.2	3.07	16.7	1.42	7.7	2.37	12.9	18.43	100.0	5.6
1978	7.41	39.3	1.06	5.6	3.43	18.2	3.02	16.0	1.41	7.5	2.52	13.4	18.85	100.0	2.3
1979	7.03	38.0	1.08	5.8	3.31	17.9	2.83	15.3	1.59	8.6	2.67	14.4	18.51	100.0	−1.8
1980	6.58	38.6	1.07	6.3	2.87	16.8	2.51	14.7	1.47	8.6	2.56	15.0	17.06	100.0	−7.8
1981	6.59	41.0	1.01	6.3	2.83	17.6	2.09	13.0	1.47	9.1	2.07	13.0	16.06	100.0	−5.9
1982	6.54	42.7	1.01	6.6	2.67	17.5	1.72	11.2	1.50	9.8	1.86	12.2	15.30	100.0	−4.7
1983	6.62	43.5	1.04	6.8	2.69	17.7	1.42	9.3	1.51	9.9	1.95	12.8	15.23	100.0	−0.5
1984	6.69	42.5	1.18	7.5	2.84	18.1	1.37	8.7	1.57	10.0	2.08	13.2	15.73	100.0	3.3
1985	6.83	43.4	1.22	7.8	2.87	18.2	1.20	7.6	1.60	10.2	2.01	12.8	15.73	100.0	—
1986	7.03	43.2	1.30	8.0	2.91	17.9	1.42	8.7	1.51	9.3	2.11	12.9	16.28	100.0	3.5
1987	7.21	43.3	1.39	8.3	2.98	17.9	1.26	7.6	1.61	9.7	2.22	13.2	16.67	100.0	2.4
1988	7.34	42.5	1.45	8.4	3.12	18.1	1.38	8.0	1.66	9.6	2.33	13.5	17.28	100.0	3.7

Source: Energy Information Administration

REFINED PRODUCT PRICES

	Regular motor gasoline pump price (¢/gal)	No. 2 heating oil retail price (¢/gal)	Average landed cost of crude imports ($/bbl)	Refiners' acquisition cost composite ($/bbl)
1977	63.07	47.37	14.31	11.96
1978	65.71	50.80	14.38	12.46
1979	87.79	72.80	21.65	17.72
1980	121.72	100.97	33.95	28.07
1981	131.10	124.66	36.52	35.24
1982	122.20	120.86	33.18	31.87
1983	115.70	110.12	28.93	28.99
1984	112.90	111.97	28.46	28.63
1985	111.50	107.55	26.66	26.75
1986	85.70	83.45	13.49	14.55
1987	89.70	85.15	17.65	17.90
1988	89.95	84.63	14.09	14.71

Source: Energy Information Administration
U.S. Dept. of Labor

U.S. ENERGY CONSUMPTION BY SOURCE

(Quadrillion BTU)

	Petroleum	% of total	Natural gas	% of total	Coal	% of total	Nuclear	% of total	Hydro and other	% of total	Total
1974	33.455	46.1	21.732	30.0	12.663	17.5	1.272	1.8	3.421	4.6	72.543
1975	32.731	46.4	19.948	28.3	12.663	17.9	1.900	2.7	3.303	4.7	70.545
1976	35.175	47.3	20.345	27.4	13.584	18.3	2.111	2.8	3.147	4.2	74.362
1977	37.122	48.7	19.931	26.1	13.922	18.2	2.702	3.5	2.612	3.5	76.289
1978	37.965	48.6	20.000	25.6	13.765	17.6	3.024	3.9	3.335	4.3	78.089
1979	37.123	47.1	20.666	26.2	15.039	19.1	2.776	3.5	3.293	4.1	78.898
1980	34.202	45.0	20.394	26.9	15.423	20.3	2.739	3.6	3.197	4.2	75.955
1981	31.931	43.2	19.928	26.9	15.907	21.5	3.008	4.1	3.216	4.3	73.990
1982	30.231	42.7	18.505	26.1	15.322	21.6	3.131	4.4	3.659	5.2	70.848
1983	30.054	42.6	17.357	24.6	15.894	22.6	3.203	4.5	4.016	5.7	70.524
1984	31.051	41.9	18.507	25.0	17.070	23.0	3.553	4.8	3.920	5.3	74.101
1985	30.922	41.8	17.834	24.1	17.478	23.7	4.149	5.6	3.562	4.8	73.945
1986	32.196	43.4	16.708	22.5	17.262	23.3	4.471	6.0	3.600	4.8	74.237
1987	32.865	43.1	17.668	22.5	18.008	23.6	4.906	6.4	3.278	4.4	76.768
1988	34.209	42.7	18.489	23.1	18.840	23.5	5.678	7.1	2.919	3.6	80.135

Source: Energy Information Administration

The increase in demand for energy in the form of electrical power has been the primary reason for the increase in coal consumption and nuclear power generation. This is due to the changing nature of the economy. This is also part of the shift to a more service-oriented, information-oriented and automated economy.

Coal energy consumption moved up 34.7% between 1973 and 1985. Coal increased its share of the total energy market from 17.5% to 23.6% in 1985. Coal consumption fell 1.2% in 1986 and coal's market share slipped to 23.3%. Coal rebounded in 1987 moving up 4.3%. The market share moved back up to 23.5%. In 1988 coal energy consumption increased another 4.6%. Share of the market stayed at 23.5%.

In 1986 a sluggish economy, particularly in the industrial sector, had an impact on coal. And coal found itself losing market share to cheap residual fuel oil. That was only a temporary phenomenon, but it did signal the possibility of oil recapturing some of the utility and industrial sector if the price was competitive. Multi-fuel capability makes fuel switching much easier now than in past years.

Energy from nuclear electric power increased 524%, from 0.91 quads in 1973 to 5.68 quads in 1988. The nuclear share of the energy market increased from 1.2% in 1973 to 7.1% in 1988.

Other forms of energy, primarily hydroelectric and geothermal, provided only 3.3% of total energy consumed in 1988. This is down from 4.1% in 1973. But this is a temporary weather related drop in energy output from hydropower. Most of this energy comes from hydropower, where the maximum capacity cannot change easily from year to year and output is dependent upon the weather. Low rain and snowfall reduced hydropower in 1987 and 1988.

Over the 1973 to 1985 period, the petroleum share of the energy market fell from 46.9% to 41.8%. Energy from petroleum in 1985 was 11.2% lower than 1973, while total energy consumption was down only 0.5%. Lower prices boosted petroleum consumption in 1986 and it increased 4.1%, capturing 43.4% of the energy market. It slipped to 42.8% of the market share in 1987 and 42.7% in 1988 as energy demand moved up faster than petroleum demand.

The natural gas share of the total energy market has fluctuated more from year to year than petroleum, but it has also moved down since 1973. Natural gas represented 30.3% of the market in 1973 but was down to 22% in 1987. It moved up slightly to 23.1% in 1988. Natural gas lost some market share to cheap residual fuel oil in the industrial and utility markets, when prices were low in 1986. Natural gas consumption fell to 16.71 quads in 1986, down 25.8% from 1973. It moved back up to 17.67 quads in 1987 and 18.49 quads in 1988.

In 1973, petroleum and natural gas combined accounted for 77.2% of the energy consumed in the U.S.. This was down to 65.8% in 1988, a definite downward trend, but still almost two-thirds of all energy consumed in the U.S.

ECONOMIC GROWTH AND ENERGY CONSUMPTION

	GNP constant 1982 dollars (Billion)	Total energy consumption (Trillion BTU)	Total energy consumption per GNP dollar (Thousand BTU)	Petroleum energy consumption (Trillion BTU)	Petroleum energy consumption per GNP dollar (Thousand BTU)
1929	711.8	23,756	33.4	5,521	7.8
1933	501.6	16,900	33.7	4,833	9.6
1940	775.0	23,589	30.4	7,407	9.6
1946	1,077.8	30,494	28.3	10,002	9.3
1950	1,206.6	33,992	28.2	13,489	11.2
1955	1,494.9	39,703	26.6	17,524	11.7
1960	1,665.3	44,569	26.8	20,067	12.1
1965	2,087.6	53,343	25.6	23,242	11.1
1970	2,416.2	67,143	27.8	29,537	12.2
1971	2,484.8	68,348	27.5	30,570	12.3
1972	2,608.5	71,643	27.5	32,966	12.6
1973	2,744.1	74,282	27.1	34,840	12.7
1974	2,729.3	72,543	26.6	33,455	12.3
1975	2,695.0	70,546	26.2	32,731	12.1
1976	2,826.7	74,362	26.3	35,175	12.4
1977	2,958.6	76,289	25.8	37,122	12.5
1978	3,115.2	78,088	25.1	37,965	12.2
1979	3,192.4	78,898	24.7	37,123	11.6
1980	3,187.1	75,952	23.8	34,202	10.7
1981	3,248.8	73,989	22.8	31,931	9.8
1982	3,166.0	70,840	22.4	30,232	9.5
1983	3,279.1	70,497	21.5	30,054	9.2
1984	3,501.4	74,101	21.2	31,051	8.9
1985	3,619.0	73,945	20.4	30,922	8.5
1986	3,718.0	74,237	20.0	32,196	8.7
1987	3,854.0	76,768	19.9	32,665	8.5
1988	4,024.4	80,135	19.9	34,209	8.5
1989E	4,114.5	81,425	19.8	34,770	8.5
Percentage change:					
1929-40	+8.9	−0.7	−9.0	+34.2	+23.1
1940-50	+55.7	+44.1	−7.2	+82.1	+16.7
1950-70	+100.2	+97.5	−1.4	+119.0	+8.9
1970-88	+66.6	+19.3	−28.4	+15.8	−30.3

E - Estimate

Source: Energy Information Administration

FUEL COMPETITION. Adjustment to the rising cost of energy not only took the form of conservation, but also the form of fuel switching. The transition to a greater capacity for fuel switching took time. It was a reaction to the price shift that was spread out over several years. It required a substantial capital investment in most cases and therefore was dependent upon a more lengthy complex economic evaluation, an evaluation which included the capital investment cost of alternative fuel facilities.

It is evident from the 1986 and 1987 energy statistics that substantial multi-fuel capability is available in the industrial and utility sectors and, to a lesser extent, in the residential sector. This has enabled the end users to adjust their energy consumption and choose the lowest cost fuel. In many instances in 1986, this turned out to be fuel oil. And it was a surprise to see a rebound in heavy fuel oil consumption. Although slow to react, natural gas prices and coal prices were forced to adjust to the competition from fuel oil. When fuel oil prices moved back up in 1987, demand for fuel oil dropped and demand for coal and natural gas rebounded. The net result of this substantial multi-fuel capacity is to keep the BTU cost of competing fuels quite close to each other.

The most competitive interfuel market is in the industrial and utility sectors where residual fuel oil competes directly with both natural gas and coal. And the demand for residual fuel oil is also affected by the expansion of nuclear fuel capacity for generating electricity.

The cost of fuels delivered to steam-electric utility plants gives a good picture of how the relative cost of competing fuels has shifted over the past several years. Coal has been, and still is, the cheapest fuel, followed by natural gas, and then heavy fuel oil, or resid, as the most expensive. But the price differentials between the fuels has changed over time. And for a short period of time in 1986, there was an unprecedented change: for the first time the cost of resid fell below that of natural gas.

In 1973 the cost of heavy oil for steam-electric utility plants was 193.8% of the cost of coal, and heavy oil was 232.2% of the cost of natural gas. These relative prices moved up to heavy oil 348.2% of coal and 190.2% of natural gas in 1981. Natural gas prices were also moving up rapidly over this period. The utility plant average cost for all fossil fuels increased 373.9% from 1973 to its peak in 1981. Since 1981, heavy fuel costs have fallen considerably. The costs of coal and natural gas slowed their rate of increase during the 1981–1984 period, and fell slightly in 1985. For year 1985, the cost of heavy oil for utilities was 257.5% of coal and 123.7% of natural gas. As oil prices plummeted in 1986 the relationship changed rapidly. For the first time, in April 1986 the cost of resid to the utility plants fell below the cost of natural gas.

By July 1986 resid prices had fallen 56.6% from the December 1985 price. At that time the resid price was 117.2% of coal and only 85.2% of natural gas.

In the face of this stiff competition from residual fuel oil, both natural gas prices and coal prices fell. Resid prices began to move up again toward the end of 1986, and by November resid had lost its absolute price advantage over natural gas.

The average price of resid delivered to electric utility plants for 1986 was down 43.4%. And for the year the resid price was 152.1% of coal and 102.4% of natural gas. This was a substantial change in the competitive differentials, from those in 1981.

During 1986 the cost of coal to electric utilities fell 4.2% and the cost of natural gas was down 31.7%. The average cost for all fuels fell 16.5%. This is a good example of the intense competition between the fuels.

The 1986 price competition from fuel oil brought the cost of these competing fuels much closer together than they had been in years. During 1987, resid prices moved up along with crude prices. The cost of heavy fuel oil for steam electric utility plants increased 23.9%. But coal and natural gas prices fell as they attempted to recapture this market. The cost of coal fell 4.6% and natural gas slipped 4.7%. For all of 1987, the resid price was 197.6% of coal and 133.2% of natural gas. The next year, 1988, was almost a repeat of 1986. The cost of heavy fuel oil fell 19.3%. Coal costs fell 2.6%, but natural gas moved up 1.3%. Heavy fuel oil costs were 163.8% of coal and only 106.1% of natural gas. Fuel oil gained a bit of the market with the lower prices.

Since the peak in 1981, the cost of all fossil fuels for electric utilities was down 27.1% in 1988. The cost of heavy oil was down 54.9%, natural gas down 19.3% and coal down 4.2%.

It is expected that with the extensive multi-fuel capacity and the lower price level for crude oil, their relative prices will remain quite close and competitive.

There are a couple of other factors which may also have an impact on this fuel competition. With repeal of the Fuel Use Act the limitation on the use of natural gas by heavy industry and utilities is eliminated. And environmental concerns over coal use may make it a more costly fuel if substantial investment is required to meet environmental restrictions. This could make both residual fuel oil and natural gas more competitive in that market.

PETROLEUM PRODUCT DEMAND. At the lower price level that has prevailed over the past few years, demand for petroleum products has moved up significantly. Demand increased 555,000 b/d in 1986. At the time that was the largest year to year increase in petroleum product demand since 1977. Demand

ENERGY CONSUMPTION—END USER SECTOR

	Residential and commercial	% of total	Industrial	% of total	Transportation	% of total	Total energy consumption
	(Quadrillion BTU)						
1974	23.72	32.7	30.70	42.3	18.12	25.0	72.54
1975	23.90	33.9	28.40	40.3	18.25	25.8	70.55
1976	25.02	33.6	30.23	40.7	19.11	25.7	74.36
1977	25.39	33.3	31.08	40.7	19.82	26.0	76.29
1978	26.09	33.4	31.39	40.2	20.61	26.4	78.09
1979	25.81	32.8	32.62	41.3	20.47	25.9	78.90
1980	25.65	33.8	30.61	40.3	19.70	25.9	75.96
1981	25.24	34.1	29.24	39.5	19.51	26.4	73.99
1982	25.63	36.2	26.14	36.9	19.08	26.9	70.85
1983	25.63	36.3	25.76	36.5	19.13	27.2	70.52
1984	26.49	35.7	27.74	37.5	19.87	26.8	74.10
1985	26.75	36.2	27.08	36.6	20.12	27.2	73.95
1986	27.02	36.4	26.45	35.6	20.77	28.0	74.24
1987	27.74	36.1	27.65	36.0	21.38	27.9	76.77
1988	29.11	36.3	29.14	36.4	21.89	27.3	80.14

Source: Energy Information Administration

REFINED PETROLEUM PRODUCTS SUPPLIED TO END-USE SECTORS

	Residential and commercial	% of total	Industrial	% of total	Trans.	% of total	Electric utilities	% of total	Total	% of total
	(Million b/d)									
1974	2.04	12.2	4.30	25.8	8.84	53.1	1.48	8.9	16.66	100.0
1975	1.95	11.9	4.04	24.8	8.95	54.8	1.39	8.5	16.33	100.0
1976	2.12	12.1	4.45	25.5	9.37	53.7	1.52	8.7	17.46	100.0
1977	2.14	11.6	4.82	26.2	9.76	52.9	1.71	9.3	18.43	100.0
1978	2.07	11.0	4.87	25.8	10.16	53.9	1.75	9.3	18.85	100.0
1979	1.73	9.3	5.34	28.9	10.01	54.0	1.44	7.8	18.52	100.0
1980	1.52	8.9	4.84	28.4	9.55	56.0	1.15	6.7	17.06	100.0
1981	1.33	8.3	4.27	26.6	9.49	59.1	0.96	6.0	16.05	100.0
1982	1.24	8.1	4.06	26.5	9.31	60.9	0.69	4.5	15.30	100.0
1983	1.29	8.5	3.86	25.3	9.40	61.7	0.68	4.5	15.23	100.0
1984	1.34	8.5	4.11	26.1	9.71	61.8	0.56	3.6	15.72	100.0
1985	1.35	8.6	4.02	25.5	9.87	62.8	0.48	3.1	15.72	100.0
1986	1.35	8.3	4.08	25.0	10.22	62.8	0.64	3.9	16.28	100.0
1987	1.37	8.3	4.24	25.4	10.51	63.0	0.55	3.3	16.67	100.0
1988E	1.41	8.1	4.37	25.5	10.71	62.4	0.68	4.0	17.17	100.0

Source: Energy Information Administration

moved up an additional 384,000 b/d in 1987 and then jumped up 618,000 b/d in 1988.

Prior to the sharp price hike in the 1979–1981 period, it was felt that petroleum demand was not related to or affected by the price level. But at that time it also was not thought that the price of crude oil could take such gigantic swings.

The initial sharp increase in prices took analysts by surprise in the 1970's and early 1980's. And then the sharp drop in oil prices in 1986 took the vast majority of analysts by surprise again.

When prices moved up sharply in 1979–1981, petroleum demand reacted and began to fall. Petroleum demand in the U.S. peaked in 1978 prior to the second price shock and then fell for five consecutive years. This decline was unprecedented in duration. Domestic demand for petroleum products had increased for 31 consecutive years from 1942 to 1973. The only downturn of any duration has been during the great depression, when demand fell for three consecutive years between 1929 and 1932.

Following the price rise in 1973–1974, demand for petroleum products fell 5.7% from 17.308 million b/d to 1973 to 16.322 million b/d in 1975. When prices then leveled, demand resumed its increase, rising for 3 more years to peak at 18.847 million b/d in 1978. Over that three-year period, 1975–1978, demand increased 2.525 million b/d, 15.5%.

The second price hike put an end to the steady rise in demand for petroleum products. It had an almost immediate impact on demand. Demand fell 3.616 million b/d over the next 5 years to 15.231 million b/d in 1983. This was a drop of 19.2% and put demand back at the 1971 level, 12 years earlier. Price induced conservation was the major reason for the decline, but sluggish economic activity also contributed to the drop in petroleum demand.

Demand for petroleum products increased in 1984 after the five consecutive years of decline. Lower prices for petroleum products, and substantial economic growth, helped boost demand 3.2% in 1984 to 15.726 million b/d. Demand remained at this level in 1985 as economic growth slowed. The substantial drop in prices stimulated petroleum product demand in 1986 and it jumped up 3.5% to 16.281 million b/d. Product demand moved up another 2.4% to 16.665 million b/d in 1987. This was the highest level of demand since 1980. In 1988 low product prices again stimulated demand and it moved up 3.7% to 17.283 million b/d, the highest level of demand in the 1980's.

In recent years, the trend in demand for petroleum products has been quite different for the various economic sectors. When prices moved up sharply from 1978–1981, demand fell in all sectors. But when prices started falling, demand reacted differently in the various sectors.

The sharpest decline has been in consumption by electric utilities. Since 1978, electric utilities have moved away from oil to coal and nuclear. Demand dropped from 1.75 million b/d to 490,000 b/d in 1985, down 72%. The share of total petroleum demand has fallen from 9.3% to only 3.1%. Competition from nuclear power, coal and natural gas have all reduced demand in this sector. In 1986, for the first time since 1978, consumption of petroleum products by electric utilities moved up. Because of the lower price, consumption jumped up 30.6% to 640,000 b/d. This represented 3.9% of total petroleum product consumption. But with the increase in prices in 1987, demand slipped again to 550,000 b/d, 3.3% of total consumption. With lower prices again prevailing in 1988, electric utility consumption jumped again to 680,000 b/d. It is obvious that demand in this sector is extremely sensitive to prices.

Industrial sector demand peaked in 1979 at about 5.35 million b/d. It fell to an estimated 3.85 million b/d in 1983 down 27.4%. It has moved back up in recent years to an estimated 4.24 million b/d in 1987, and 4.37 million b/d in 1988.

The industrial sector share of total domestic demand has not changed a great amount. It was 25.9% in 1973, and moved up to 28.9% in 1979. It fell to 25.3% in 1983 but moved back up slightly to 25.4% in 1987, and 25.5% in 1988.

Residential and commercial sector demand was trending down from 1973 to 1982, dropping 44.4% from 2.23 million b/d to 1.24 million b/d in 1982. This sector's share of the total fell from 12.9% to 8.1%. Conversion to natural gas and the use of natural gas for new buildings because of the price advantage was the main reason for the downward shift. Demand in this sector has been on the rise over the past three years, moving up to 1.37 million b/d in 1987, and 1.41 million b/d in 1988. This was 8.3% of total demand in 1987 and 8.1% in 1988.

Transportation sector demand had been on the rise since 1982, and the share of total demand has been constantly increasing since 1977. It passed the 1979 peak in 1986 and set an all time high in 1988 at 10.71 million b/d.

Transportation demand hit 10.15 million b/d in 1978, but then fell 8.3% to 9.31 million b/d in 1982. The major reasons for the decline were improved efficiency of motor vehicles, and cost consciousness and conservation by drivers.

Transportation demand has been increasing again since 1982, and in 1988 was up 15% from that recent low. The transportation sector's share of total petroleum demand has moved up from 52.9% in 1977 to 63% in 1987 and 62.4% in 1988. Lower gasoline prices, and the fact that petroleum products do not have major competition from other fuels in the transportation sector, have stimulated demand.

One of the things that was underestimated or ignored in some of the older forecasts was the price elasticity of demand for petroleum products; that is, the change in demand relative to a change in price. There is no way to isolate demand for petroleum products and measure only the response due to price change. But the sharp price hikes, particularly in the late 1970's, enable the calculation of a rough estimate of elasticity. Over the past few years, the elasticity of demand for all petroleum products has been approximately 0.1. For every 10% increase in the price, demand fell 1%. This varied from product to product.

Although this would indicate that demand was relatively "inelastic," it does show that, contrary to some past theories of ever increasing petroleum demand, demand would fall if the price increase was too great.

From 1970 to 1981, the composite U.S. refiner acquisition cost of crude oil increased 936%, from $3.40/bbl to $35.24/bbl. This is an increase of $31.74/bbl and an annual average increase of 23%/year. Crude oil prices determine product prices, and therefore, they also skyrocketed. These massive price increases, far surpassing the overall rate of inflation, had a tremendous impact on investment and consumption decisions and resulted in a reduction in demand for oil products.

Since 1981, the price of crude oil has been falling. The composite U.S. refiner acquisition cost for 1984 was $28.63/bbl. This was a drop of 18.8% from the 1981 average price. Demand rebounded in 1984, increasing 3.2%. This is a roughly 1.7% increase in demand for every 10% decrease in price.

In 1985, the refiner acquisition cost fell an additional 6.5%, but demand remained at the same level as 1984. This would indicate an even lower elasticity of demand, closer to 1% change for every 10% shift in price, since 1981. In 1986, the refiner composite acquisition cost of crude oil fell another 45.6% to $14.55/bbl. In response, demand moved up 3.5%. In 1987, the refiner acquisition cost of crude moved back up to $17.91/bbl and demand still moved up, increasing 2.4%. In 1988 the price slipped again falling 17.8% and total demand jumped up 3.7%.

From 1981 through 1988, the cost of crude to the refiner is down 58.3%. Since hitting a low in 1983, demand increased 13.5% Although there was a delayed response, this indicates approximately a 2.3%

EXPORTS OF REFINED PRODUCTS AND CRUDE

	1978	1980	1981	1982	1983	1984	1985	1986	1987	1988
					(1,000 b/d)					
Gasoline	2	1	2	20	10	6	10	33	35	22
Distillate	3	3	5	74	64	51	67	100	66	69
Residual	13	34	118	209	185	190	197	147	186	200
Lubricants	27	23	19	16	16	15	15	23	23	26
Coke	111	137	138	156	195	193	187	238	213	231
Asphalt and road oil	1	1	—	1	1	1	—	1	1	1
LPG	20	21	42	65	73	48	62	42	38	49
Other refined products	27	39	43	38	31	37	39	47	51	62
Total refined products	**204**	**259**	**367**	**579**	**575**	**541**	**577**	**631**	**613**	**660**
Crude	158	287	228	236	164	181	204	154	151	155
Total exports	**362**	**546**	**595**	**815**	**739**	**722**	**781**	**785**	**764**	**815**

Source: Energy Information Administration

increase in demand for every 10% drop in price. These are very rough measures, but they do indicate a price elasticity that should be taken into account when projecting demand. There are obviously many factors affecting demand, but relative price is a key one. However, it will take a longer period to determine if demand elasticity is close to this estimate.

The impact of price on motor gasoline demand has not been as great as some other petroleum products, but it has been significant. Demand peaked in 1978 at 7.412 million b/d and then fell 11.8% to 6.539 million b/d in 1982.

The price of gasoline obviously influenced driving behavior, reducing the number of miles driven and changing attitudes about type of vehicles. Drivers cut out a lot of wasteful discretionary driving and also opted to purchase more fuel-efficient vehicles. A major result of the rapid increase in price was the federal government-mandated vehicle fuel efficiency standards. This forced improvement in vehicle fuel efficiency. Gasoline demand fell about 1% for every 10% increase in price during that period of decline. Over that period there was also a significant improvement in the fuel efficiency of the vehicle fleet.

As prices have been on the decline in the last few years some of the conservation impact has diminished and motor gasoline demand has increased. The average pump price for motor gasoline fell below $1/gal for the first time since 1979, declining to 93.1 cts/gal in 1986. When adjusted for inflation the average price of motor gasoline in 1986 was the lowest ever recorded. And motor gasoline demand responded moving up 3% to the highest level since 1979 at 7.034 million b/d. This was only the fourth year on record where gasoline demand exceeded 7 million b/d.

Prices moved up only marginally in 1987 to 95.7 cts/gal. This low price level continued to stimulate demand, which moved up to 7.206 million b/d. This was the second best year in history, surpassed only by 7.412 million b/d in 1978. The average pump price moved up only marginally again in 1988 to 96.3 cts/gal. Demand continued to increase to 7.336 million b/d, moving closer to the record.

With the real, inflation-adjusted price at or near historical lows, individual discretionary conservation diminishes substantially. Motor gasoline demand of 7.336 million b/d in 1988 was up 12.2% since the recent low in 1982. The average pump price for all types of motor gasoline was down 28.8% from the peak of $1.353/gal in 1981. That would represent a 4.2% increase in demand for each 10% decline in price.

The level of demand for motor gasoline is affected by a number of competing factors: vehicle fuel efficiency, average miles driven per vehicle, and total number of vehicles in the fleet.

The total number of vehicles registered has been steadily increasing. It had reached 179 million in 1987, up 13.5% from 1981 the year of peak gasoline prices. Car registrations were 137.3 million, up 11.5%. Miles traveled per car in 1987 was 9,883, up 7.6% from the 9,186 in 1981. Miles driven per car was at an all-time high of 10,521 in 1972.

These factors are offset by the improved vehicle efficiency and declining fuel consumption per vehicle. The average miles driven per gallon of gas consumed was 19.17 in 1987. This is up 20.3% since 1981, and up 48.2% from the low of 13.3 miles per gallon in 1973.

Highway and rail transport, and residential and commercial heating are the major uses for distillate. Demand for distillate fuel oil also peaked in 1978, at 3.432 million b/d. It then fell sharply, 22.2%, to 2.671 million b/d in 1982.

Between 1978 and 1981, the price of home heating oil increased 165.1% from 38.7cts/gal to $1.026/gal. This resulted in a shift to natural gas for heating, an increase in personal conservation and a sharp cut in fuel oil used. During the decline, distillate demand fell about 1.25% for every 10% increase in price.

Distillate prices have also been falling since 1981. As a result distillate demand has been moving back up since 1982. Demand moved up 15.7% from 1982 through 1988. Distillate demand moved up 1.6% in 1986 as prices fell sharply. It then moved up another 2.1% in 1987 and 4.9% in 1988 when prices softened again.

Highway diesel distillate demand is closely related to the level of economic activity. It has been increasing as the economy has expanded. This trend is expected to continue with diesel consumption moving up along with economic activity.

This increase in distillate demand has been partially offset by a decline in demand for home heating oil. Home heating oil has been losing share in the residential and commercial heating market to natural gas. As oil prices have declined, conversions to natural gas have slowed but natural gas is still gaining market share. Natural gas or electric home heating are capturing a major share of new construction.

Changes in demand for residual fuel oil has accounted for a large share of the change in total petroleum product demand. Between 1978, the year of peak petroleum demand, and 1985, total petroleum product demand was down 3.121 million b/d. Residual fuel oil demand in 1985 was 1.202 million b/d down 1.821 million b/d from the 1978 level. The drop in resid consumption was 58.3% of the decline in total petroleum consumption. Resid demand in 1985 was down 60.9% from the peak in 1977 of 3.071 million b/d.

The shift by electric utilities from residual fuel oil to cheaper fuel sources such as coal, nuclear and hydro, was the major reason for the drop in resid demand. In 1978, almost half of the resid consumed was by the utility sector, 48.3% or 1,461 million b/d. By 1985, utility sector demand had fallen 71% to an estimated 424,000 b/d. Industrial demand was also down sharply, falling from 622,000 b/d in 1978 to an estimated 182,000 b/d in 1985.

The resid demand response to the price increases was a lot greater than for some other products. With more competition from competing fuels, resid demand tends to be more "elastic." Resid demand fell about 3% for every 10% increase in price.

In 1986, demand jumped up 18%, an increase of 216,000 b/d. The much lower crude and resid prices enabled resid to recapture a portion of the industrial and utility demand for heavy fuel oil. The increase in resid demand accounted for 36.4% of the total increase in demand in 1986.

Resid demand slipped in 1987, falling to 1.264 million b/d, down 10.9%. Higher prices in 1987 decreased its competitive position in the electric utility and industrial sectors.

Falling prices again boosted demand for resid in 1988. Demand rebounded, increasing 114,000 b/d, 9%, to 1.378 million b/d. Electric utility consumption was up 24.5%, to 625,000 b/d.

The long range demand for resid will depend upon its competitive price compared to natural gas and coal. Projecting beyond the forecast period the fuel source for growing electrical power demand is in doubt. There is little if any additional nuclear power capacity planned beyond the mid 1990's. Environmental concerns over acid rain are growing and this may put some temporary economic limitations on the growth of coal consumption. This may open up an opportunity for renewed demand for heavy fuel oil, to meet electric utility fuel requirements.

Other petroleum products demand has also been moving up over the past few years. Demand for jet fuel has moved up rapidly over the period 1982–1988. Total demand for jet fuel has increased 43.6% to 1.45 million b/d in 1988. The increase has been in demand for kerosine jet fuel for commercial aircraft. Deregulation in the airline industry has led to keen competition along with fare slashing. The ability to cut fares was assisted by lower fuel cost. The lower fares stimulated interest in travel by air. The result was a substantial increase in passenger traffic and a jump in jet fuel demand. This trend is expected to continue along with the growth in the economy.

Demand for all other products also moved up faster than total demand. This group includes petrochemical feedstocks, lubricants, still gas, waxes, asphalt, coke and others. Demand is expected to continue to move up. It will be driven by petrochemical demand, asphalt demand and lubricant demand. Asphalt demand is expected to be high for some time due to the needs to repair and resurface the state and interstate highways.

OUTLOOK

In the past two editions of the *Oil Industry Outlook* it has been stated that "the combination of lower oil prices, lower petroleum product prices and increased economic activity will give a boost to U.S. petroleum demand over the forecast period." And a very similar statement can be applied to this outlook. The above analysis was true for the past two years and it will probably hold for the near future.

Demand for energy and petroleum products is very dependent upon the level of economic activity and will tend to follow the trends in economics growth. But economic growth is also influenced by energy costs. The relatively lower oil and energy costs we are experiencing now, and expect to see in the future, will help boost the rate of economic growth. The cost of energy is not the only factor influencing economic growth, but it is very important.

The rate of economic growth will be modest over the forecast period, with the economy expanding at an average annual rate of about 2.7%. The economy will not be expanding at a level close to its potential, but it is not expected to slide into a recession during this period. However, it is expected to slow to a 2.2% rate in 1991.

Lower energy costs should help to prevent a recession during the forecast period. Lower energy costs and lower interest rates should boost investment and productivity, but potential growth will be moderate due to the overhanging burden of huge government, corporate and personal consumer debt. The economic growth rate will probably be slowed during the forecast period, as attention is diverted from productive activity to debt management. It is expected that the economy will slow substantially in 1991 and might be in danger of recession.

If the debt problem can be dealt with effectively, then the economy should rebound and economic growth will pick up toward the end of the forecast period. GNP will be moving up at an annual rate of 2.5–3.5% over the 1992–1994 period.

Lower energy costs, lower interest rates and increased productivity could actually combine to give the economy a very vigorous boost, but this is dependent upon a resolution of that hefty debt problem. Real GNP is forecast to be up 14.6% by 1993.

Because of the much lower cost of energy, it is expected that energy consumption will move up at a faster rate relative to GNP than the average since 1970. Total energy is expected to increase at an average annual rate of about 1.6%, more than half the growth rate of GNP.

Energy efficiency improvements would continue, but they will be more than offset by the increase in energy consumption to support economic growth. With the lower-cost energy, there will be less conservation and more energy consumption than with the higher prices.

The trend in the relationship of energy to real GNP will continue down the path of increased energy efficiency. Energy required per dollar of real GNP will drop to 18,695 BTU by 1993, a further 5.6% improvement in energy efficiency.

Total energy demand will increase 8.2% over the forecast period. Energy from petroleum is

REAL PRICE OF GASOLINE

	Regular leaded gasoline price (ct/gal)	Real price* (1967 $)
1919	25.47	49.12
1920	29.83	49.70
1921	26.31	49.11
1922	25.20	50.18
1923	21.97	43.02
1924	20.95	40.88
1925	22.20	42.26
1926	23.38	44.14
1927	21.09	40.54
1928	20.94	40.79
1929	21.42	41.73
1930	19.95	39.87
1931	16.98	37.26
1932	17.93	43.81
1933	17.82	45.95
1934	18.85	47.04
1935	18.84	45.84
1936	19.45	46.83
1937	19.99	46.50
1938	19.51	46.21
1939	18.75	45.05
1940	18.41	43.87
1941	19.23	43.60
1942	20.43	41.83
1943	20.53	39.60
1944	20.59	39.06
1945	20.50	38.02
1946	20.77	35.52
1947	23.11	34.55
1948	25.88	35.92
1949	26.79	37.54
1950	26.76	37.14
1951	27.15	34.89
1952	27.56	34.65
1953	28.69	35.80
1954	29.04	36.08
1955	29.07	36.24
1956	29.93	36.76
1957	30.96	36.74
1958	30.38	35.09
1959	30.49	34.94
1960	31.13	35.12
1961	30.76	34.33
1962	30.64	33.81
1963	30.42	33.16
1964	30.35	32.65
1965	31.15	32.96
1966	32.08	32.99
1967	33.16	33.16
1968	33.71	32.35
1969	34.84	31.73
1970	35.69	30.69
1971	36.43	30.03
1972	36.13	28.83
1973	38.82	29.17
1974	52.41	35.48
1975	57.22	35.50
1976	59.47	34.88
1977	63.07	34.75
1978	65.71	33.63
1979	87.79	40.38
1980	119.10	48.26
1981	131.10	48.15
1982	122.20	42.27
1983	115.70	38.77
1984	112.90	36.29
1985	111.50	34.61
1986	85.70	26.10
1987	89.70	26.35
1988	89.95	26.29

*Average annual gasoline price deflated by consumer index.

expected to increase at a slightly slower rate than overall energy, moving up 7.7%. Lower prices will make petroleum very competitive with other energy sources. But improved efficiency will reduce the rate of growth of consumption below the rate for total energy.

Energy from nuclear power is expected to increase 9.2% over the period. This is a rate much lower than in previous five year outlooks. This is growth from new plants already under construction and increased output from existing facilities. Nuclear will have 7% of total energy in 1994, no higher than it is at present. There will be little growth, if any, in nuclear energy beyond 1993.

Energy from coal will continue to move up slowly over the five year period. Increased competition from petroleum will slow growth in coal. But the market share will remain at about 23.4% in 1994. Coal took over as the second leading fuel source in 1986 and will retain this position. Coal growth will be restrained due to environmental concerns with clean air and acid rain.

The petroleum share of the energy market will slip marginally over the forecast period falling from 42.7% in 1989 to 42.5% in 1994. The lower price level will enable petroleum to compete more effectively in the energy market.

Natural gas is expected to lose market share falling from 23% in 1988 to 22.5% in 1994. To a great extent, natural gas has taken over petroleum's role as the swing energy source. This may change with repeal of the Fuel Use Act and more innovative and aggressive gas marketing.

Petroleum and natural gas in combination will account for 65% of total energy needs in 1994. This will be down only slightly from 65.7% in 1989. It is obvious that these energy sources will be extremely important to the U.S. economy for the foreseeable future.

The energy market is expected to become more competitive over the forecast period. It is also expected that the price/cost of competing fuels will continue to converge over the 1989–1994 period and will move in similar directions and close together throughout the five years.

Petroleum energy demand is made up of demand for a variety of individual petroleum products. Demand for each of these products is affected differently by the price level, the level of economic activity and the intensity of competition from other energy.

In general, the combination of lower oil prices and continued economic growth will stimulate total demand for petroleum products over the forecast period. Total domestic demand will increase 7.7% over the forecast period, moving up to 18.910 million b/d. This will be a volume increase of 1.35 million b/d, which would be a record high level of demand. This would move above the 1977–1979 period when annual demand was over 18.4 million b/d. The highest year to date was 1978 when demand averaged 18.847 million b/d.

Motor gasoline demand will move up over the forecast period, but not as rapidly as overall demand. Demand for gasoline will increase 2.8% to 7.63 million b/d in 1994. This would also be a record high.

The total vehicle fleet is expected to increase as well as the miles driven annually per vehicle. But this will be offset by the improvement in vehicle fuel efficiency. The increase in demand will depend upon the strength of these factors.

Gasoline prices will move up over the forecast period, increasing about 20.3%. But increased economic activity will give the driving segment of the population more discretionary income to spend on travel. The real price of gasoline adjusted for inflation is expected to increase only about 4% over the five year forecast period. The real price is expected to be at a level comparable to the early 1970's. Therefore, there is not expected to be a great deal of reason for motorists to exercise a lot of discretionary conservation.

Demand for jet fuel is expected to continue to climb throughout the forecast period. Although competition in the airline industry may slacken in intensity over the forecast period it is expected that demand will be spurred by increased economic activity and relatively low air fares.

Demand will increase approximately 13.4% to 1.69 million b/d. Increased economic activity will create additional demand for air service. Relatively low fuel costs will enable airlines to continue to engage in fare competition. The result will be increased demand for jet fuel.

Distillate demand is also expected to move up over the forecast period, stimulated by increased economic activity. A large percentage of distillate demand is for diesel fuel for transport and this is directly related to overall economic activity. As economic activity increases, diesel fuel demand will move up. This will be offset by declining distillate demand for residential and commercial heating. Demand in the heating sector is losing market share to natural gas and more efficient electrical heating systems. Total distillate demand is projected to increase 7.9% over the forecast period to 3.43 million b/d in 1994.

The level of demand for residual fuel oil is the key to the level of future total demand for petroleum products. If crude and resid prices are low enough so that resid can compete in the electric utility and industrial sectors, resid demand could increase sharply. The sharp drop in prices in 1986 led to a sharp increase in resid demand. This gave economic evidence of the price level at which resid can compete with natural gas and coal for the industrial and electric utility markets.

Resid prices moved back up in 1987 and resid lost a lot of the market share it gained in 1986. But then prices dipped in 1988 and resid demand rebounded and was fairly strong. The generally low price level slowed the decline in resid in 1987 and 1988, and should help boost demand over the forecast period.

With little if any planned expansion of nuclear facilities beyond 1990 and with environmental concerns about expanding coal consumption, a gap will develop for fuel for power generation. Resid is expected to fill a portion of that gap starting in 1991. Therefore, over the entire forecast period resid demand is expected to increase 300,000 b/d, 21.4%, to 1.7 million b/d in 1994.

With a lower price level for petroleum products, in general, demand for all of the other diverse petroleum products is also expected to move up along with economic activity. Ethane and LPG demand is projected to increase 11.8% and other product demand is projected to increase 8% by 1994.

One factor that is holding back a major resurgence in oil demand is the long-range price expectations. Since increased demand of any significant amount must be met by OPEC production, potential customers are reluctant to commit to capital equipment that requires oil consumption. OPEC is not noted for exhibiting price restraint when the market conditions are in their favor. Even though market conditions may be different now than in the 1970's, the return to oil as a fuel source will be cautious over the forecast period. Major consumers are preparing for any potential fuel price shock by obtaining multi-fuel capability.

THE OUTLOOK — U.S. DEMAND

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
ENERGY DEMAND (trillion BTU)									
Petroleum	34,209	34,770	35,290	35,760	36,450	36,960	37,460	+2,690	+ 7.7
Natural gas	18,489	18,735	18,850	19,030	19,250	19,570	19,850	+1,115	+ 6.0
Coal	18,840	19,090	19,260	19,500	19,800	20,150	20,620	+1,530	+ 8.0
Nuclear	5,678	5,680	5,850	6,060	6,150	6,200	6,200	+520	+ 9.2
Hydro and other	2,919	3,150	3,500	3,750	3,900	3,950	4,000	+850	+27.0
Total	**80,135**	**81,425**	**82,750**	**84,100**	**85,550**	**86,830**	**88,130**	**+6,705**	**+ 8.2**
PETROLEUM DEMAND (thousand barrels/day)									
Motor gasoline	7,336	7,420	7,460	7,495	7,550	7,590	7,630	+210	+ 2.8
Jet fuel	1,449	1,490	1,540	1,580	1,635	1,660	1,690	+200	+13.4
Distillate fuel oil	3,122	3,180	3,210	3,240	3,310	3,375	3,430	+250	+ 7.9
Residual fuel oil	1,378	1,400	1,450	1,530	1,600	1,650	1,700	+300	+21.4
Ethane and LPG	1,656	1,700	1,750	1,780	1,820	1,860	1,900	+200	+11.8
Other products	2,342	2,370	2,420	2,445	2,495	2,525	2,560	+190	+ 8.0
Total	**17,283**	**17,560**	**17,830**	**18,070**	**18,410**	**18,660**	**18,910**	**+1,350**	**+ 7.7**
CRUDE OIL PRICE ($/barrel)									
U.S. average wellhead	12.57	14.90	14.75	15.65	17.50	19.00	20.00	+5.10	+34.2
West Texas intermediate (posted)	15.52	18.30	18.10	19.20	21.45	23.30	24.50	+6.20	+33.9
MOTOR GASOLINE PUMP PRICE (average all types) ($/gallon)	0.963	1.085	1.075	1.115	1.180	1.245	1.305	+0.220	+20.3
ECONOMIC ACTIVITY Gross National Product (GNP) (billion 1982 dollars)	4,024	4,113	4,213	4,306	4,457	4,577	4,714	+601	+14.6

U.S. DEMAND—KEYS TO THE FUTURE

1. Economic expansion is projected to continue throughout the forecast period, but at a slower rate of growth than over the past several years. Inflation will not be a major problem, but the rate will be up from the past few years. Overhanging government deficits and consumer debt problems will probably slow the rate of growth to a crawl in one of the early years of the forecast period.

2. Relatively low energy and petroleum product prices will continue throughout the forecast period. Prices will move up faster than the rate of inflation, but remain well below the peak 1980–1985 period.

3. The combination of continued economic growth and low energy prices will boost energy consumption throughout the forecast period. Lower energy costs will reduce the incentive for conservation. Energy efficiency will improve, but the rate of improvement will be slowed. Technological breakthroughs with respect to more energy efficient equipment and motors could have an impact by the end of the forecast period.

4. Demand for petroleum products will move up at a rate of growth close to the rate of growth of total energy demand. Low prices will help stimulate consumption of petroleum products throughout the forecast period. The level of total demand will be very dependent upon the need for heavy fuel oil for electric power generation.

5. Demand for motor gasoline will increase throughout the forecast period, but at a very modest rate. Vehicle efficiency will continue to rise as the older cars are replaced. But the increased efficiency will be offset by increased miles driven and an increase in the number of vehicles. The increased population and increased affluence will boost the vehicle fleet substantially.

6. Continued economic expansion will result in increased electric power consumption. The cap on nuclear power growth will necessitate electric utilities turning to heavy fuel oil for some of the future power generation. Therefore, demand for heavy fuel oil, resid, will pick up toward the end of the forecast period.

7. In the future, environmental concerns will have an increasing and substantial impact on decisions concerning energy consumption. It is presently difficult to quantify the impact, but it will probably lead to higher cost energy.

U.S. OUTLOOK—SUPPLY

In general, the U.S. is a high cost producing area for crude oil and natural gas. Therefore, the current lower level of crude oil and natural gas prices continues to have a substantial impact on the supply outlook for the U.S. Lower prices stimulate demand, but they also tend to depress output, particularly in the higher cost production areas like the U.S.

Crude oil production in the U.S. is not demand constrained as is OPEC output. There is no excess capacity problem in the U.S. The U.S. is not self-sufficient in crude oil and therefore has been importing crude oil and products for a long time. There is no problem in finding a market for domestic production.

The availability of U.S. domestic crude oil is related to the worldwide price of crude oil and the current domestic cost of production. A substantial volume of U.S. production is relatively high cost production. And high cost production volume is much more sensitive to any significant change in price. This is not the case for production in some of the prolific low cost areas such as the Middle East.

The recent high price era, 1980–1985, stimulated U.S. production. At those price levels, U.S. production actually started to move back up after

U.S. LIQUIDS PRODUCTION AND RESERVES

	1973	1975	1977	1978	1979	1981	1982	1983	1984	1985	1986	1987	1988	% change 88/78	% change 88/73
	(1,000 b/d)														
Crude & condensate production:															
California	921	883	958	935	966	1,055	1,100	1,109	1,126	1,161	1,114	1,084	1,054	12.7	14.4
Kansas	181	162	158	153	156	180	193	196	207	207	184	164	161	5.2	−11.0
Louisiana	2,278	1,790	1,542	1,460	1,355	1,231	1,256	1,314	1,408	1,392	1,403	1,320	1,217	−16.6	−46.6
New Mexico	276	259	239	230	217	196	195	206	217	215	207	198	195	−15.2	−29.3
North Dakota	55	56	64	64	84	124	130	139	144	139	125	113	107	67.2	94.5
Oklahoma	524	447	428	418	393	422	435	435	460	446	409	368	352	−15.8	−32.8
Texas	3,546	3,347	3,117	2,948	2,776	2,589	2,535	2,473	2,472	2,435	2,300	2,137	2,062	−30.1	−41.8
Wyoming	389	349	306	376	361	358	324	324	340	352	332	316	311	−17.3	−20.1
Others	839	872	904	872	843	808	785	778	783	799	739	687	664	−23.9	−20.9
Total Lower 48	**9,009**	**8,171**	**7,716**	**7,456**	**7,151**	**6,963**	**6,953**	**6,974**	**7,157**	**7,146**	**6,813**	**6,387**	**6,123**	**−17.9**	**−32.0**
Alaska	199	191	463	1,245	1,402	1,609	1,696	1,714	1,722	1,825	1,867	1,962	2,017	62.0	913.6
Total U.S.	**9,208**	**8,362**	**8,179**	**8,701**	**8,553**	**8,572**	**8,649**	**8,688**	**8,879**	**8,971**	**8,680**	**8,349**	**8,140**	**−6.4**	**−11.6**
NGL production:															
Total U.S.	1,738	1,633	1,618	1,567	1,584	1,609	1,550	1,559	1,630	1,609	1,551	1,595	1,625	3.7	−6.5
Total liquids production:															
Total U.S.	10,946	9,995	9,797	10,268	10,137	10,181	10,199	10,247	10,509	10,580	10,231	9,944	8,765	−4.9	−10.8
	(Million bbl)														
Total U.S. Reserves															
Crude	35,299	32,682	29,486	27,804	27,051	29,426	27,858	27,735	28,446	28,416	26,889	27,256	26,825	−3.5	−24.0
NGL	6,455	6,268	5,994	5,926	5,655	7,068	7,221	7,901	7,643	7,944	8,165	8,147	8,238	39.0	27.6
Total	**41,754**	**38,950**	**35,480**	**33,730**	**32,706**	**36,494**	**35,079**	**35,636**	**36,089**	**36,360**	**35,054**	**35,403**	**35,063**	**4.0**	**−16.0**
	(Years)														
Reserves/production ratio:															
Crude	10.50	10.71	9.88	8.75	8.67	9.40	8.82	8.75	8.75	9.00	8.49	8.94	9.00		
NGL	10.18	10.52	10.15	10.36	9.78	12.04	12.76	13.89	12.81	13.85	14.42	13.99	13.85		
Total	**10.45**	**10.58**	**9.92**	**9.00**	**8.84**	**9.82**	**9.42**	**9.53**	**9.38**	**9.81**	**9.39**	**9.75**	**9.81**		

Source: American Petroleum Institute; Energy Information Administration

several years of decline. Capital investment flowed into the industry, activity hit record highs, new reserves were found and output moved higher.

But that trend changed abruptly in 1986 when crude prices plummeted. Particularly in the U.S. lower-48, maintaining production was dependent upon drilling thousands of new wells. At the lower 1986 price level, much of the drilling activity became uneconomic. In addition to the curtailment of new exploration, many marginal producing wells were considered uneconomic and were shut in. The end result was the start of a slide in U.S. production that has continued through 1989, and is expected to continue throughout the forecast period. The slide was accelerated in 1989 as Alaskan North Slope production peaked and started down.

In the past, the supply response to price changes had been relatively slow. But this is the only time in recent years that there has been a price drop of this magnitude. And the response has been a definite and significant decline in U.S. output.

In the long run, domestic demand for petroleum products can be met by domestic production and/or imports of crude oil and products. Since U.S. domestic production is unable to support total domestic demand for petroleum products, a substantial and growing volume of imports is required. Imports are the swing supply source, and vary with demand. But the future picture is rather clear. With increasing demand and declining production, increased imports will be required to fill the widening gap between domestic demand and domestic supply.

In the short run, crude and product stocks can help to satisfy demand, but only temporarily. Stocks have already been cut down close to minimum operating requirements and therefore will not provide a major source of supply over the forecast period.

REVIEW

TOTAL LIQUIDS PRODUCTION. Crude and condensate production has been sliding in the U.S. since the early part of 1986. The downward slide has continued throughout 1986, 1987, 1988 and 1989. The precipitous drop in the wellhead price of U.S. crude oil in 1986 was the major reason the slide started. Even though prices rebounded somewhat in 1987, the increase was not sufficient to stop the

CRUDE AND PRODUCT IMPORTS: RELATION TO DEMAND

	1973	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	% change 78/73	% change 88/78
	(1,000 b/d)														
Imports:															
Crude*	3,244	6,594	6,195	6,452	5,219	4,141	3,323	3,096	3,229	3,083	4,130	4,601	5,056	+ 91.0	− 18.4
Products	3,012	2,193	2,008	1,937	1,646	1,599	1,625	1,722	2,011	1,866	2,045	2,004	2,295	− 33.3	+ 14.3
Total	**6,256**	**8,787**	**8,203**	**8,389**	**6,865**	**5,740**	**4,948**	**4,818**	**5,240**	**4,949**	**6,175**	**6,605**	**7,351**	**+ 31.1**	**− 10.4**
Domestic demand	17,308	18,431	18,847	18,513	17,056	16,058	15,296	15,231	15,726	15,726	16,281	16,665	17,283	+ 8.9	− 8.3
Dependency ratio: Imports/demand	36.2	47.7	43.5	45.3	40.3	35.8	32.4	31.6	33.3	31.5	37.9	39.6	42.5		

* Excludes imports for Strategic Petroleum Reserve.
Source: Energy Information Administration

SPOT MARKET VOLUMES

Year	U.S. Imports (Thousand barrels per day) Total: industry imports	Fixed price contract	Spot market
1975	6,056	5,871	185
1976	7,313	7,018	295
1977	8,786	8,346	440
1978	8,201	7,751	450
1979	8,389	7,884	505
1980	6,866	6,386	480
1981	5,740	5,165	575
1982	4,948	3,958	990
1983	4,817	2,887	1,930
1984	5,240	2,358	2,882
1985	4,949	985	3,964
1986	6,176	620	5,556
1987	6,605	660	5,945
1988	7,351	730	6,621

Note: Spot market volumes include for 1983 and 1984 contract volumes where the price is directly related to spot market prices and fluctuates with the spot market prices. This might be more aptly labeled "volumes traded on the spot market and at market related prices."

Source: Energy Information Administration and Author's estimates

decrease in U.S. production. Prices slipped again in 1988 and the decline actually began to accelerate.

U.S. crude and condensate production declined from 9.477 million b/d in 1972 to 8.132 million b/d in 1976, a drop of 1.345 million b/d, or 14.2%. With the development of the Alaskan North Slope, production jumped to 8.707 million b/d in 1978. But the decline in lower-48 production pulled the total down again in 1979 as total U.S. production fell to 8.552 million b/d.

This downward slide stopped in 1979 and was reversed by the drilling boom of 1980–1982. The high domestic crude prices resulting from the OPEC price increase of 1979–1981 stimulated domestic exploration and development. At these higher prices, production from many marginal low-volume U.S. wells became profitable. Drilling activity increased markedly because of the increased profitability of smaller discoveries.

Initially the drilling boom arrested the decline and U.S. production remained fairly constant, with 8,597 million b/d in 1980 and 8.572 million b/d in 1981. But over the next four years production moved up. The substantial accumulation of new wells, coupled with increased Alaskan output, boosted total production to 8.971 million b/d in 1985. The higher prices and corresponding increasing in drilling activity helped push up U.S. production 399,000 b/d, up 4.7%.

The price of crude oil had been the determining factor in increasing production. Prior to that period, the almost unanimous expectations were for declining U.S. production, particularly in the lower-48 states. This rapid increase in price stimulated domestic exploration and drilling, and encouraged the development of previously uneconomic reserves. The drilling and development surge over the 1979–1982 period helped slow the expected decline rate in the lower-48 states. In fact, lower-48 output actually moved up over the 1981–1985 period.

Prior to the drilling boom the decline in lower-48 production had been somewhat masked by increased Alaskan production. Lower-48 production fell from 9.275 b/d in 1972 to 6.953 million b/d in 1982, a drop of 2.322 million b/d, down 25%.

Effects of the drilling boom began to show up in 1983, as lower-48 output moved up marginally to 6.974 million b/d. This was an increase of 21,000 b/d; only 0.3%, but a complete reversal of the expected constant rate of decline. Lower-48 production continued to move up in 1984 with output of 7.157 million b/d. Production in 1985 was sustained at close to this level with 7.146 million b/d.

Sliding prices had slowed drilling activity from 1983–1985. But the sharp drop in prices in 1986 led to a drop in drilling activity to the lowest level ever recorded. Coupled with the shutting in of marginal wells this led to a drop in lower-48 production of

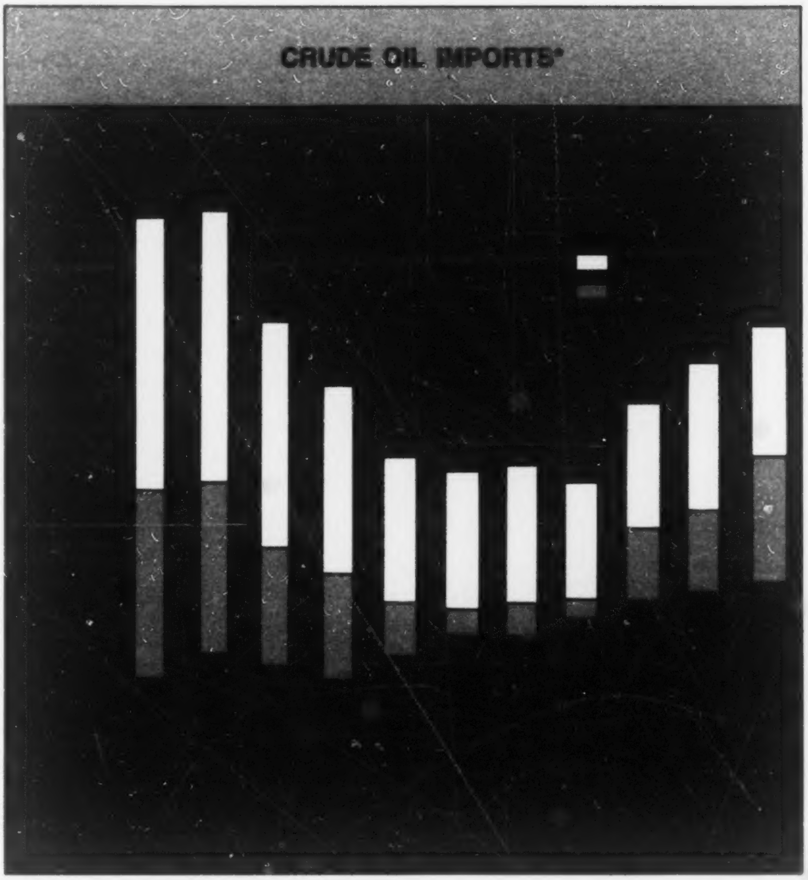
333,000 b/d, 4.7%, to 6.813 million b/d for 1986. This was the lowest level of lower-48 production since 1955.

Production continued to slide in 1987 even though there was a slight increase in prices. Lower-48 output fell an additional 426,000 b/d to 6.387 million b/d. Alaskan production increased 95,000 b/d in 1987 so total U.S. output was down only 331,000 b/d. Lower-48 production continued to drop during 1988. It averaged 6.123 million b/d, down another 264,000 b/d. The slide has continued in 1989. Lower-48 production is estimated for 1989 at 5.893 million b/d, down another 230,000 b/d. Since the recent drilling boom high of 7.157 million b/d in 1984, lower-48 output has fallen an estimated 1.264 million b/d, 17.7% in five years.

Part of the decline in lower-48 output had been offset by increasing Alaskan production until 1989. The Alaskan North Slope was developed in 1977 and 1978. The first full year of North Slope production, 1978, Alaskan output was 1.229 million b/d. Production from the North Slope moved up steadily through 1988.

Alaskan production in 1988 reached 2.017 million b/d. Production in 1988 was up 295,000 b/d since 1984, and offset 28.5% of the drop in lower-48 output.

But this changed in 1989. Lower prices curtailed some exploration plans in Alaska. Concern over the environmental impact, particularly after the Valdez tanker accident, also slowed production and future development. This allowed the natural decline to take over on the North Slope and Alaskan production fell for the first time in 1989. Output for the year is estimated to be down 135,000 b/d to about 1.882 million b/d.



CRUDE OIL IMPORTS*

If future development plans are delayed substantially, then Alaskan production could fall more rapidly in the future. This will result in a much faster decline rate for total U.S. output of crude oil.

Also contributing to total liquids output is NGL production. NGL production has not varied greatly over the past several years. Output varies with the relative economics associated with gas liquids products. It is dependent upon the cost of extraction versus the market value of the products. Producers have the flexibility of varying the extraction rate of liquids from gas, dependent upon the economics.

From 1975–1980, NGL output averaged 1.596 million b/d. Over the next five years, 1981–1985, output averaged 1.591 million b/d. Output hit a low of 1.55 million b/d in 1982, but was up to 1.63 million b/d in 1984 and 1.609 million b/d in 1985. As a result of lower prices NGL production fell sharply in 1986 to 1.551 million b/d. Output rebounded in 1987 to 1.595 million b/d, and then moved up to 1.625 million b/d in 1988. It is expected to remain close to 1.6 million b/d during 1989.

Total liquids production, crude and condensate plus NGL, was 10.008 million b/d in 1987. This was down 546,000 b/d, 5.4% since 1984. Total liquids production for 1988 was 9.818 million b/d, down 736,000 b/d, 7% since 1984. This is the first time since 1977 that total liquids production has fallen below 10 million b/d, and it will be only the third year since 1967.

RESERVES. The level of oil reserves and the ratio of proven reserves to current production are key indicators of future production potential.

Total U.S. crude oil reserves fell sharply from 1970 through 1979. Reserves were at a peak in 1970 at 39 billion barrels due to the addition of Prudhoe Bay in Alaska. By 1979 estimated reserves had slipped to 27.1 billion barrels, down 30.6%.

The drilling boom in the U.S. from 1979–1982, which followed the sharp increase in prices, slowed the expected decline in U.S. reserves and temporarily reversed the long-run decline. Reserves moved back up and were 28.4 billion barrels in 1985.

But the sharp drop in prices in 1986 also took its toll on crude reserves. Estimated reserves fell 5.4% to 26.9 billion barrels. This moved back up in 1987 to 27.3 billion barrels. The increase was due to a large revision rather than increased exploration. The reserve estimate fell another 1.6% to 26.825 billion barrels in 1988. The record low level of drilling activity is the major reason for the continued decline.

The reserves/production ratio is a good indicator of potential future production. In 1970, the year of peak U.S. reserves, the ratio was 11.09 years. The ratio slipped to 10.68 years in 1975 and then slipped sharply to 8.84 years in

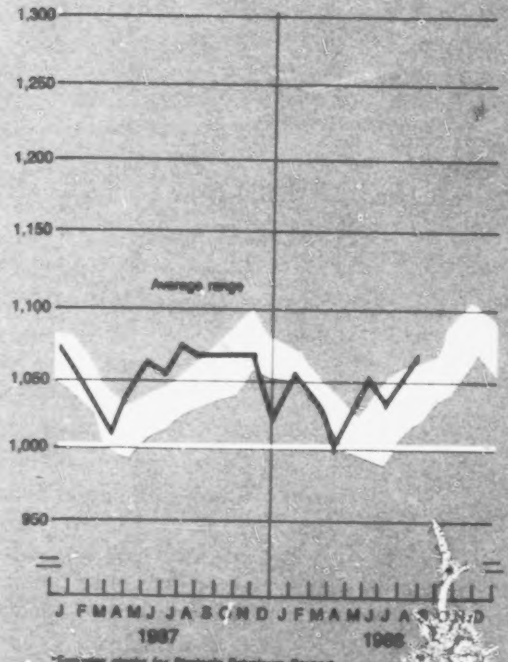
CRUDE IMPORTS BY COUNTRY OF ORIGIN

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
						(1,000 b/d)					
Eastern Hemisphere:											
Algeria	634	608	457	261	90	176	194	84	78	115	58
Angola	6	39	37	45	42	71	85	104	102	180	203
Egypt	20	55	31	33	40	25	10	3	10	54	26
Gabon	38	42	25	35	40	59	57	51	25	35	15
Libya	638	642	549	317	23	—	—	—	—	—	—
Nigeria	910	1,069	843	611	510	301	207	280	437	529	607
Other Africa*	30	42	62	32	30	48	65	62	89	84	102
Total Africa	**2,276**	**2,497**	**2,004**	**1,334**	**775**	**680**	**618**	**584**	**741**	**997**	**1,011**
Kuwait	5	5	27	—	2	7	24	4	28	70	80
Oman	61	37	24	24	22	34	10	2	8	35	7
Qatar	64	31	22	7	7	—	4	—	12	—	—
Saudi Arabia	1,142	1,347	1,254	1,112	530	321	309	132	618	642	902
United Arab Emirates	385	281	173	77	81	18	90	35	38	56	23
Other Middle East*	623	395	38	6	38	58	23	72	100	182	389
Total Middle East	**2,280**	**2,096**	**1,538**	**1,226**	**680**	**438**	**460**	**245**	**804**	**985**	**1,401**
Indonesia	533	380	315	318	226	315	304	292	297	262	186
Malaysia	37	55	61	33	18	3	—	1	11	12	19
Other Far East*	—	—	1	—	11	7	40	56	80	127	154
Total Far East	**570**	**435**	**377**	**351**	**255**	**325**	**344**	**349**	**388**	**401**	**359**
Norway	104	75	144	114	102	65	112	31	53	70	62
United Kingdom	169	197	174	369	441	365	378	278	317	304	254
Other Europe*	10	8	—	—	—	3	3	1	9	1	5
Total Europe	**275**	**280**	**318**	**483**	**543**	**433**	**493**	**310**	**379**	**375**	**321**
Other Eastern Hemisphere†	8	3	—	37	54	91	120	53	30	—	—
Total Eastern Hemisphere	**5,409**	**5,311**	**4,237**	**3,431**	**2,307**	**1,967**	**2,035**	**1,541**	**2,342**	**2,758**	**3,091**
Western Hemisphere:											
Brazil	—	—	1	14	19	2	—	—	—	—	—
Ecuador	38	30	17	38	22	56	47	56	64	23	33
Mexico	316	436	508	469	645	766	658	715	621	602	674
Peru	18	40	41	30	21	8	1	12	9	1	5
Trinidad-Tobago	—	—	115	102	92	83	87	98	93	75	71
Venezuela	181	293	156	147	155	164	253	305	416	488	439
Other Latin America*	2	—	3	—	—	4	1	—	63	119	112
Total Latin America	**555**	**799**	**841**	**800**	**964**	**1,083**	**1,047**	**1,186**	**1,266**	**1,308**	**1,335**
Canada	248	271	200	164	214	274	341	468	570	608	681
Other Western Hemisphere†	144	124	—	1	3	5	3	6	—	—	—
Total Western Hemisphere	**947**	**1,194**	**1,041**	**965**	**1,181**	**1,362**	**1,391**	**1,660**	**1,836**	**1,916**	**2,015**
Total Crude Imports	6,356	6,505	5,278	4,396	3,488	3,329	3,426	3,201	4,178	4,674	5,107
Less: SPR Imports	162	67	44	256	165	234	197	118	48	73	51
Crude Imports (ex. SPR)	6,194	6,438	5,234	4,140	3,323	3,095	3,229	3,083	4,130	4,601	5,056
OPEC Imports	5,184	5,112	3,864	2,922	1,734	1,477	1,512	1,312	2,113	2,400	2,626
% OPEC Imports	81.6%	78.6%	73.2%	66.5%	49.7%	44.4%	44.1%	41.0%	50.6%	51.4%	52.8%

*May include data on countries listed specifically but for which no individual data are reported.
†Includes data which could not be broken down by country or continent.
Source: Energy Information Administration

STOCKS

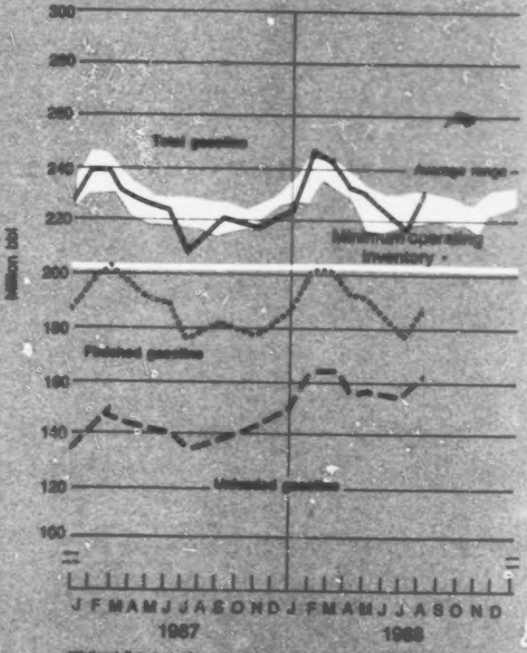
Crude oil & pet. prod.*



*Excludes stocks for Strategic Petroleum Reserve

Source: Energy Information Administration

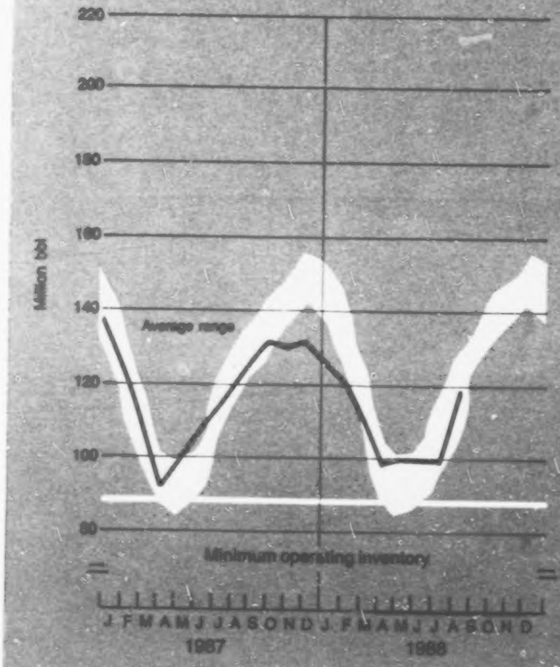
Motor gasoline



*National Petroleum Council estimate

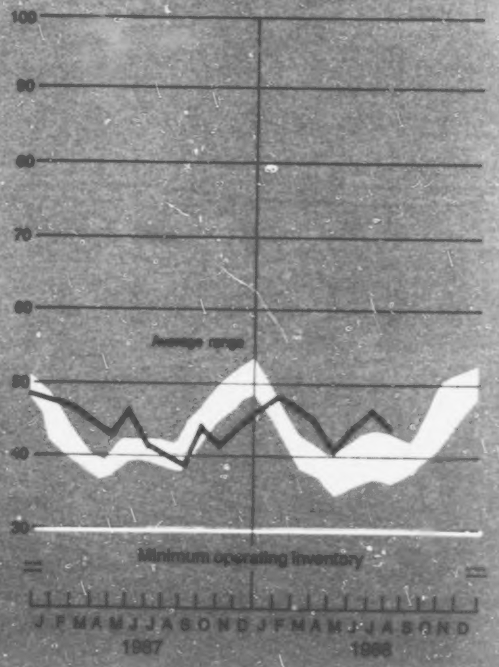
Source: Energy Information Administration

Distillate fuel oil



Source: Energy Information Administration

Residual fuel oil



Source: Energy Information Administration

NEW YORK MERCANTILE EXCHANGE

Total annual contract volumes
Thousand contracts
(Million barrels)

Year	Total oils	Crude oil	Heating oil	Leaded gasoline*	Unleaded gasoline
1978	50	—	50	—	—
1979	100	—	100	—	—
1980	240	—	240	—	—
1981	1,010	—	950	60	—
1982	1,850	—	1,725	125	—
1983	2,625	350	1,850	425	—
1984	4,589	1,840	2,092	654	3
1985	6,989	3,981	2,208	667	133
1986	12,858	8,314	3,275	830	439
1987	20,931	14,582	4,293	—	2,056
1988	27,086	18,859	4,935	—	3,292

Trading vs. Deliveries
(Thousand barrels)

	Total deliveries	Trading volume	Deliveries as % of trading volume
Crude oil			
1984	66,780	1,494,976	4.5
1985	157,991	3,581,102	4.4
1986	276,127	7,312,164	3.8
1987	434,032	12,986,458	3.3
1988	612,282	18,518,125	3.3
Heating oil			
1984	28,772	2,117,019	1.4
1985	29,861	2,069,901	1.4
1986	48,216	3,034,981	1.6
1987	79,810	4,021,241	2.0
1988	157,554	4,923,343	3.2
Unleaded gasoline			
1985	6,684	116,252	5.7
1986	14,068	276,619	5.1
1987	52,645	1,891,088	2.8
1988	127,558	3,053,868	4.2

* Leaded gasoline trading ended Oct. 1986.
Sources: NYMEX (New York Mercantile Exchange)

1979 just before the large drilling boom.

The ratio jumped to 9.84 years in 1980 and 9.82 years in 1981 along with the increased drilling activity. The ratio slipped to 9.42 years by 1985. It then slipped in 1986 to 8.5 years, an historic low for this ratio. It moved up slightly in 1987 to 8.9 years and in 1988 to 9 years. Production slipped faster than reserves between 1986 and 1988, causing the increase in the ratio.

These low ratios should serve as a signal that action should be taken to stimulate exploration activity. Replacing reserves is essential to the long-term viability of the U.S. domestic industry and to U.S. energy security. And it is apparent that a massive exploration and drilling effort is essential to accomplish a turn around in the reserves estimates.

IMPORTS. To fill the growing gap between declining U.S. petroleum production and increasing U.S. demand for petroleum products, imports have been rising rapidly in recent years. The role of crude oil and petroleum product imports in U.S. supply is increasing rapidly. U.S. domestic liquids production is not sufficient to meet U.S. demand. Therefore, imports are essential fill the gap between domestic demand and domestic production.

Imports are the swing source of petroleum and vary with the magnitude of the gap between domestic demand and domestic production. Since domestic demand is moving up and domestic production is on the decline, that gap is widening and imports are once again on the rise. Imports are rapidly reaching a level of over half of U.S. supply.

It should be noted here that the imports of concern are industry imports. Imports for the strategic petroleum reserve (SPR) are not included in this analysis. They are more of a national security issue at this point. Until their role in meeting supply need is better defined, the SPR reserves are not a factor in the demand-supply equation. What is needed is a sound mechanism in place that defines the way the SPR reserves will be used in an emergency situation. Without that mechanism their use becomes a political issue. An efficient mechanism for their use in balancing the market would require immediate response. By the time a political debate is completed the market will have reacted to the emergency.

Total U. S. imports peaked in 1977 at 8.787 million b/d. This was during the era of rapidly rising demand. As demand fell, following the huge increase in prices, imports were reduced. Demand fell 3.616 million b/d over the period, 1978 through 1983. This decline in demand resulted in a drop in imports. Imports fell to 4.818 million b/d in 1983, down 3.969 million b/d, 45.2%. Imports absorbed the entire drop in U.S. demand. In addition, increased domestic production and stock adjustments backed out an additional 353,000 b/d in imports.

As demand began to rise, total imports jumped up in 1984 to 5.24

STOCK LEVELS AND DAYS' SUPPLY

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Stocks: (1,000 bbl)												
Crude oil*	339,813	309,421	339,080	358,166	363,464	349,730	343,850	345,376	320,892	331,224	348,995	330,359
Products	947,479	896,003	911,784	926,262	889,843	786,367	730,698	760,346	704,561	749,723	717,808	707,358
Total	**1,287,292**	**1,205,424**	**1,250,864**	**1,284,482**	**1,253,307**	**1,136,097**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**	**1,066,803**	**1,037,717**
SPR†	7,540	58,796	117,687	123,938	230,341	293,827	379,089	450,505	493,316	511,565	540,648	559,515
Demand: (1,000 b/d)												
Products supplied	18,431	18,847	18,513	17,056	16,058	15,296	15,231	15,726	15,726	16,281	16,665	17,283
Days supply:												
Product stocks	51.41	47.54	49.25	54.31	55.41	51.41	47.97	48.35	44.80	46.05	43.07	40.93
Total stocks	**69.84**	**63.96**	**67.57**	**75.31**	**78.04**	**74.27**	**70.55**	**70.31**	**65.21**	**66.39**	**64.02**	**60.04**

*Excluding SPR. †Strategic Petroleum Reserve.

Source: Energy Information Administration

U.S. REFINED PRODUCTS, NATURAL GAS LIQUIDS, AND CRUDE STOCKS

Refined product stocks	1979	1980	1981	1982*	1983	1984	1985	1986	1987	1988
					1,000 bbl					
Gasoline	240,159	264,011	256,425	247,085	225,042	246,307	225,148	235,490	228,514	230,771
Motor†	237,503	261,327	253,001	244,279	222,434	243,296	222,839	233,057	226,183	228,403
Aviation†	2,656	2,684	3,424	2,806	2,608	3,011	2,309	2,433	2,331	2,368
Special naphthas	4,196	4,929	3,965	3,474	3,153	2,951	3,909	3,759	3,654	3,487
Kerosine	15,821	11,568	11,042	10,792	7,861	11,893	7,502	8,379	8,447	7,284
Distillate	228,706	205,113	191,541	185,579	140,263	161,072	143,673	155,097	134,485	123,517
Residual	95,859	91,786	77,992	66,229	48,504	53,000	50,381	47,437	47,410	44,621
Kerosine jet fuel	32,926	35,723	34,011	32,001	32,346	35,118	33,825	42,677	41,973	37,723
Naphtha jet fuel	5,594	6,308	7,054	7,189	6,265	6,861	6,654	7,072	7,956	6,051
Natural gas liquids & LRG	125,597	137,460	150,170	114,497	116,817	108,446	81,707	109,532	104,119	103,988
Unfinished oils	117,652	123,938	111,348	105,277	108,018	93,506	106,656	94,022	93,185	99,858
Other refined products	45,274	45,426	46,295	44,023	42,429	41,192	45,106	46,258	48,065	50,058
Total product stocks	**911,784**	**926,262**	**889,843**	**818,146**	**730,698**	**760,346**	**704,561**	**749,723**	**717,808**	**707,358**
Crude stocks§	339,080	358,166	363,464	350,044	343,850	345,376	320 892	331,224	348,995	330,359
Total stocks	**1,250,864**	**1,284,482**	**1,253,307**	**1,168,190**	**1,074,548**	**1,105,722**	**1,025,453**	**1,080,947**	**1,066,803**	**1,037,717**

*Change in Energy Information Administration reporting basis. †Includes blending components. §Excludes stocks for Strategic Petroleum Reserve.

Source: Energy Information Administration

million b/d. But they slipped again in 1985 to 4.949 million b/d. Increased domestic production and a drop in crude and product stocks in 1985 enabled a reduction in imports. But by end 1985 stocks had been drawn down close to minimum levels. After that any increase in demand would have to be met by increased imports.

Imports jumped up sharply in 1986 as demand increased and domestic production fell. Total imports increased 24.8% in 1986 to 6.175 million b/d. This was the highest volume of imports since 1980. Imports continued to climb in 1987, filling in the growing gap between slumping U.S. production and increased demand for petroleum products. Imports moved up another 7% to 6.605 million b/d. This continue through 1988. U.S. demand continued to increase and domestic production continued to slide. Total imports moved up another 11.3%, 746,000 b/d to 7.351 million b/d in 1988. Imports in 1988 are up 52.6% since 1983. This is an increase of 2.534 million b/d.

The increase in imports has continued in 1989 with imports moving over 8 million b/d for the first time since 1979. Total imports for 1989 are estimated at 8.105 million b/d. Imports are up 3.288 million b/d, since that recent low in 1983. This is an increase of 68.3% in only six years.

The largest swings have been in imports of crude oil rather than

AVERAGE ANNUAL PRICE OF CRUDE OIL

Year	U.S. average wellhead price: Current dollars	U.S. average wellhead price: Constant 1967 dollars	Saudi Arabian light crude: Current dollars	Saudi Arabian light crude: Constant 1967 dollars
1950	2.51	3.07	—	—
1951	2.53	2.78	1.75	1.92
1952	2.53	2.86	1.75	1.98
1953	2.68	3.07	1.97	2.25
1954	2.78	3.17	1.97	2.25
1955	2.77	3.15	1.97	2.24
1956	2.79	3.08	1.97	2.17
1957	3.09	3.31	2.08	2.23
1958	3.01	3.18	2.08	2.20
1959	2.90	3.06	1.90	2.00
1960	2.88	3.03	1.80	1.90
1961	2.89	3.06	1.80	1.90
1962	2.90	3.06	1.80	1.90
1963	2.89	3.06	1.80	1.90
1964	2.88	3.04	1.80	1.90
1965	2.86	2.96	1.80	1.86
1966	2.88	2.89	1.80	1.80
1967	2.92	2.92	1.80	1.80
1968	2.94	2.87	1.80	1.76
1969	3.09	2.90	1.80	1.69
1970	3.18	2.88	1.80	1.63
1971	3.39	2.98	2.29	2.01
1972	3.39	2.85	2.48	2.08
1973	3.89	2.89	5.04	3.74
1974	6.87	4.21	11.25	7.03
1975	7.67	4.32	12.38	7.08
1976	8.19	4.45	11.51	6.29
1977	8.57	4.41	12.70	6.54
1978	9.00	4.28	12.70	6.07
1979	12.64	5.31	24.00	10.19
1980	21.59	8.03	32.00	11.91
1981	31.77	10.83	34.00	11.59
1982	28.52	9.53	34.00	11.36
1983	26.19	8.64	29.00	9.57
1984	25.88	8.34	29.00	9.35
1985	24.09	7.80	28.00	9.07
1986	12.51	4.16	15.05	5.02
1987	15.40	5.00	17.53	5.70
1988	12.57	3.87	13.71	4.22
1989E	14.90	4.41	16.30	4.83

Note: Prices for Saudi Arabian light crude are official government posted prices 1950–1985 average selling price 1986–1988

petroleum product imports. Most of the decline which occurred in the years 1977–1983 was in crude oil imports, which fell 3.498 million b/d, from 6.594 million b/d in 1977 to 3.096 million b/d in 1983, a drop of 53%. Product imports fell 471,000 b/d, 21.5%, from 2.193 million b/d to 1.722 million b/d in 1983.

Crude imports jumped up in 1984 to 3.229 million b/d but then fell again in 1985 to 3.083 million b/d. The decline in 1985 was due to increased domestic production and destocking. Crude imports jumped 34% in 1986 to 4.178 million b/d. The drop in domestic production coupled with the increase in demand led to the need for more imported crude oil. In addition, refiners took advantage of the low priced crude market to boost crude stocks 3.1%.

Crude imports continued to move up in 1987, reaching 4.601 million b/d. In 1988, crude imports jumped up another 9.9% to 5.055 million b/d. Imports for 1989 are estimated at 5.8 million b/d. This is up another 14.7%, 745,000 b/d. It is the highest level of crude oil imports since 1979, and is surpassed only by the crude import levels in the 1977–1979 period. The peak year for imports was 1977 at 6.594 million b/d.

The movement in product imports has not been as volatile, but they have followed a similar pattern. Product imports hit bottom in 1981 at 1.599 million b/d. They then moved up substantially between 1981 and 1984, increasing 25.8% to 2.011 million b/d. Product imports fell to 1.866 in 1985, primarily due to a reduction in product stocks that added 153,000 b/d to supply in 1985. Product imports jumped back up again in 1986, increasing to 2.045 million b/d, an increase of 179,000 b/d. A substantial portion of this increase was an increase in resid imports which moved up 159,000 b/d in 1986; in response to the jump in resid demand. U.S. refiners are not set up to optimize resid production so this sudden surge in demand was met by imports.

Even though resid imports fell off a bit in 1987, product imports remained relatively high at 2.004 million b/d. Resid imports fell 104,000 b/d in 1987. But part of this was made up by increased motor gasoline imports, up 58,000 b/d.

Product imports in 1988 jumped up 14.4%, an increase of 289,000 b/d, to 2.293 million b/d. The increase was in all major product groups. Motor gasoline imports were up 21,000 b/d, distillate imports were up 47,000 b/d, resid imports were up 41,000 b/d and imports of all other various petroleum products was up 125,000 b/d.

REFINED PRODUCT IMPORTS

Product imports in 1989 are estimated at 2.305 million b/d. Resid imports are expected to be up again and distillate imports are also up.

With excess domestic refining capacity, domestic refiners have more incentive to import crude, rather than products. This enables refiners to increase crude runs and lower unit refining costs. In addition, with the pattern of demand relatively uncertain, crude imports offer refiners additional flexibility. They can change yield patterns as required by demand.

But on the other hand, with worldwide excess refining capacity, imported products are often available at low prices, making product imports economically attractive. Flexibility can be retained by simply importing the product required. As additional export refineries come on stream in the Middle East, and U.S. import requirements rise, product imports may move up in the future. The determining factor will obviously be the cost of crude and processing, relative to the cost of imported products.

U.S. import dependency dropped sharply from 1977 to 1983. Prior to that period total imports as a percentage of domestic demand had risen from 29.1% in 1972 to a peak of 47.7% in 1977. With a drop in demand and declining imports, this ratio fell to 31.6% in 1983. The rebound in imports in 1984 pushed it back up to 33.3%. With the drop in imports in 1985, the dependency ratio fell to 31.5%. But then with the surge in imports in 1986 the dependency ratio shot up to 37.9%. This moved up to 39.6% in 1987 and to 42.5% 1988. The dependency ratio is estimated at 46.2% in 1989.

This ratio is expected to climb over the forecast period and be over 50% by 1992. The import dependency ratio is a key indicator of U.S. vulnerability to some form of oil supply disruption. Another indicator is the source of oil imports.

As imports declined between 1977 and 1985, and the dependency ratio fell, the source of imports shifted away from some of the more volatile areas. Imports from OPEC countries and the Persian Gulf were reduced and thus reduced the U.S. vulnerability to an oil supply disruption.

Crude imports from the Persian Gulf countries were reduced substantially, falling from 2.495 million b/d in 1977 to 245,000 b/d in 1985. Imports from OPEC countries fell 4.331 million b/d, from 5.643 million b/d in 1977 to only 1.312 million b/d in 1985. The share of U.S. crude imports from OPEC countries fell from 85.7% in 1976 to 41% in 1985. This favorable trend away from vulnerability was abruptly reversed in 1986. Crude imports from the OPEC countries jumped up to 2.113 million b/d, an increase of 61.1%. The OPEC share of U.S. crude imports increased to 50.6%. Imports from the Middle East also increased moving up to 804,000 b/d in 1986 from only 245,000 b/d in 1985. Saudi Arabia became the second leading source of imported crude providing

618,000 b/d. Mexico was the leading source at 621,000 b/d.

Crude imports from OPEC moved up to 2.4 million b/d in 1987, 51.3% of total crude imports. Saudi Arabia led the way supplying 642,000 b/d, followed by Nigeria at 529,000 b/d and Venezuela at 488,000 b/d.

Total crude and product imports from the OPEC countries moves up from 1.83 million b/d in 1985 to 3.52 million b/d in 1988. This was an increase of 92.3% in 3 years. In 1988 OPEC imports accounted for 47.6% of total U.S. imports, including the SPR imports. Saudi Arabia was the leading source in 1988 with 1.064 million b/d coming from that country. This is up from only 168,000 b/d in 1985.

Non-OPEC crude imports to the U.S. moved up from 972,000 b/d in 1977 to 2.274 million b/d in 1987. In 1987, Canada led the way at 608,000 b/d, followed by Mexico at 602,000 b/d, and the United Kingdom at 304,000 b/d.

Total imports from the non-OPEC countries was 3.882 million b/d in 1988. This is up 19.9% since 1985. In 1985 non-OPEC imports accounted for 63.9% of total U.S. imports. This was down to 52.4% in 1988.

Not only is the U.S. becoming more dependent on imported oil but it is also becoming more dependent on OPEC oil.

STOCKS. Crude and product stocks do not have a major impact on the long run demand and supply situation. However, in the short run stock swings can play a major role in determining the level of supply, the level of imports, and most significantly the short run price of crude and products. Stocks can be another source of crude oil and petroleum products. And when on the rise, they can also be an element of demand as refiners build supplies for the future.

Total crude and product stocks, excluding stocks for the Strategic Petroleum Reserve (SPR), fell 210 million bbl from year end 1980 to year end 1983. This added an average 192,000 b/d to available supply over that three year period. Stocks went up marginally, 30 million bbl, in 1984 as demand increased, but were reduced again in 1985 as refiners cut costs. Stocks fell an additional 80 million bbl, and at year end 1985 were down 259 million barrels from year-end 1980. This had added 142,000 b/d to supply over these five years.

Stocks moved up again in 1986 increasing 55 million barrels. This actually added approximately 150,000 b/d to demand in 1986. But then stocks were drawn down again in 1987 falling 15 million barrels. This added about 41,000 b/d to supply in 1987. In 1988 companies reduced total stocks 29 million b/d, adding 79,000 b/d to supply.

In the past stocks were built up substantially at certain times of the year to meet seasonal swings in demand. In addition, the industry was willing to hold stocks as a buffer against a potential supply disruption. When demand started falling in 1979, stocks were retained at a relatively high level, because there was little feeling for the extent and duration of the decline.

But the operating philosophy changed as stocks piled up and carrying costs soared. The high inflation rates of the early 1980's made it quite expensive to maintain excess unneeded stocks. To cut costs a concentrated effort was made to reduce stocks to the minimum level that was operationally feasible. Stocks were slashed and the general operating philosophy of refiners now appears to be permanently changed to maintaining stock levels close to the minimum operating level.

The build up in stocks in 1986 was mainly a result of the extremely low prices and the net back pricing schemes that surfaced at that time. Refiners built up stocks to take advantage of the low crude costs. And many of the net-back pricing arrangements made it highly profitable for refiners to purchase and store large quantities of crude. They were virtually assured of a profit on all product transactions connected to the crude purchased.

But that stock build up was only temporary. Net-back pricing schemes were abandoned by the producing countries since they appeared to be driving down the price of crude oil at the wellhead. A substantial portion of the stock build up in 1986 was worked off by mid-1987 and refiners were back to operating at minimum stock levels, in order to reduce costs.

A good measure of the adequacy of stocks to meet demand is the number of days of supply they represent. Total industry stocks represented 58 days supply in 1973. This increased to 78 days at year-end 1981. After the sharp reduction in stocks, there was some concern about the adequacy of stock levels, but stocks at year-end 1984 still represented over 70 days supply at the reduced demand level of 1984. The additional sharp cut in stocks in 1985 dropped the days supply represented by year-end 1985 total stocks to 65.2 days. This was the lowest level since 1974. This moved up to 64 days in 1987, but then dipped to 60.2 days supply in 1988. It is expected to drop marginally to 60.1 days in 1989. Stocks are at close to minimum levels and refiners will strive to maintain a balance between rising demand and stocks, and avoid any potential supply disruptions.

Most of the reduction in stocks has been product stocks. From year-end 1981 to year-end 1988 total industry stocks have been reduced 217 million barrels. Crude stocks have been reduced only 33 million barrels while product stocks have fallen 184 million barrels. Refiners find it advantageous to maintain higher crude stocks. With excess refining capacity available, refiners can run crude to meet unexpected swings in product demand.

But stocks appear to be at a minimum level if supply disruptions are to be avoided. With demand expected to rise in the future, it does not appear that stocks will be reduced substantially in the future.

Crude oil stocks in the Strategic Petroleum Reserve surpassed industry crude oil stocks in July 1983. At year-end 1988 SPR stocks were 560 million barrels while industry crude stocks were only 330 million barrels.

The fill rate for the SPR has become sort of a political football. Those placing emphasis on energy security push for a higher fill rate. While those concerned more with government expenditures and budget deficits call for a lower fill rate or total suspension of SPR crude purchases. The domestic independent producers have asked that it be filled partially with crude from domestic stripper wells so that these wells are not shut-in.

The SPR does potentially provide a back-up in case of an emergency. However, at year-end 1988 it represented only about 32.4 days of supply at the 1988 rate of demand. But the biggest problem with the SPR program is that there is no clear-cut procedure for its use in case of an emergency. Without some program for implementation the SPR is of little use in preventing a surge in prices if there is a supply disruption and the market gets out of balance.

There is an additional element of supply, primarily processing gain from refining operations. This expansion during crude processing added about 800,000 b/d to supply in 1988. It is anticipated that with demand in general going up, and demand for light products growing, processing gain will move up over the forecast period.

An added element of risk was added to the crude supply market and refinery crude trading operations over the past several years. The excess capacity situation in the world crude market led to a very competitive trading atmosphere in crude oil products. This resulted in the rapid expansion of spot market transactions and the development of a futures market for major products and crude oil. Transactions became dominated by spot market trading and/or supply contacts with the price connected to the spot market. The net-back pricing arrangements eliminated some of the risk for refiners during 1986. But those arrangements were short-lived since they tended to put additional downward pressure on prices by encouraging product price competition.

Although OPEC is trying to reestablish posted contract prices, the vast majority of the trading is still a form of spot market trading with its inherent risks. More and more refiners and others involved in trading products or crude are turning to the futures market to reduce the risk.

The future market is not a source of supply, but it does influence price and therefore supply decisions. Total annual contract volumes for crude and products traded on the New York Mercantile Exchange moved up rapidly. It went from 50,000 contracts in 1978 (50 million barrels) to 6,989,000 contracts in 1985, 12,858,000 in 1986, 20,931,000 in 1987 and 27,086,000 in 1988. The futures market has become an important barometer of the volatile movement in prices in today's market.

OUTLOOK

Increased demand for petroleum products is expected to help reduce the worldwide excess crude capacity that is putting the downward pressure on prices. Therefore, crude oil prices are projected to move up over the forecast period. But they are going to move up slowly along with increased demand, and will remain well below the high price levels that prevailed during the 1980-1985 period.

The average U.S. wellhead price for crude oil is expected to move up 34.2% to $20.00 in 1994. This is starting from the 1989 price level of an estimated $14.90/bbl. The price in 1989 is already up 18.5% from the depressed price of $12.57/bbl in 1988. The price is expected to slip in 1990 due to increased worldwide production capacity. But the decline will be relatively small if OPEC shows some production restraint. The U.S. wellhead price is projected to be $14.75/bbl in 1990. The price is then expected to move up slowly through the 1991–1994 period. Sluggish economic activity and demand for petroleum products are expected to slow the rate of increase. Prices could move up more rapidly if there was a robust resurgence in economic activity and demand for petroleum products.

The level of U.S. crude prices will be influenced by many factors. But they will track closely the level of international export prices. The real determinant of the future price level will be OPEC.

Although U.S. crude oil prices will climb substantially from this 1988 low, they will remain well below the prices that prevailed from 1980–1985. Prices jumped up to $21.59/bbl in 1980 and then to an average $31.77/bbl in 1985. Incentives for exploration, drilling and production in the U.S. were a lot greater during those years than during the 1986-1988 period. And the price increase projected will restore only a portion of the financial incentive that existed from 1980–1985.

The real, inflation-adjusted, price of U.S. crude has fallen to a level comparable to the 1974–1978 period. This was just after the first, and more moderate, price hike. Real prices are expected to move up about 15.9% between 1989 and 1994. The real price in 1994 will still be 52% lower than the peak price in 1981.

This expected price level will stimulate demand, but it is not expected to be a major stimulus for supply. That sharp drop in crude oil prices in 1986 brought the decline curve back into projections of U.S. domestic crude oil production. And the decline will continue throughout the forecast period and beyond.

The average wellhead price for U.S. domestic crude oil fell 47.4% from $24.09/bbl in 1985 to $12.66/bbl in 1986. This was a loss of $11.43/bbl. As a result of this loss of value, U.S. crude production fell 3.2%, 291,000 b/d, from 8.971 million b/d in 1985 to 8.680 million b/d in 1986. The decline from December 1985 to December 1986 was 678,000 b/d. With the prices falling back to $12.57/bbl in 1988 the slide in production continued. Production for 1989 was down another 905,000 b/d.

The initial decline in production in 1986 was a result of a combination of factors. Well drilling activity fell to the then lowest level since 1942, with an average of only 964 rotary rigs active during 1986. And secondly, a vast number of marginal stripper wells were shut in either permanently or temporarily during 1986, and their production was eliminated.

A portion of the value of the barrel was restored in 1987 as crude prices moved back up to $15.41/bbl. But this was not sufficient incentive to increase drilling activity substantially. More wells were shut-in and abandoned due to poor economics. U.S. production slipped an additional 331,000 b/d to 8.349 million b/d. Lower-48 production was down 426,000 b/d. Drilling activity sunk to a new low of 936 average active rigs in 1987 and stayed at that level in 1988.

Prices slipped again in 1988 and averaged only $12.57/bbl for the year. The expected recovery in drilling was stifled and production continued to slide. Prices moved up again in 1989, but the increase was not sufficient to stop the slide in drilling activity. It sunk to a new low of 850 active rigs.

What has happened over the last three years points out the close relationship between the crude price level, domestic drilling activity and U.S. crude production.

The high price level of the 1980–1985 period stimulated drilling and boosted U.S. production. The surge in exploration and drilling resulted in the development of smaller reservoirs and prevented the natural decline curve from taking hold in the older producing areas of the lower-48 states. As prices started to slide, drilling activity was cut back. But prices were still high enough to stimulate additional activity. And the combination of a vast number of additional wells and investment in enhanced oil recovery helped sustain production.

The sharp price break in 1986 stopped a great deal of exploration and drilling activity. It also slowed enhanced recovery projects and a lot of remedial work on old wells. The natural decline rate again took hold in the older mature fields and U.S. production fell. And it will undoubtedly continue to slide.

The projected increase in crude oil prices is expected to result in additional exploration and production activity. However, the increase will not be sufficient to prevent the decline in U.S. output. Lower-48 output will continue the slide that was restarted in 1986. And adding to the problem is the peaking and decline of Alaskan output. Prudhoe Bay production has already peaked. Without additional exploration activity total

Alaskan production has already hit its peak in 1988 and has begun to decline.

The decline rate may be slowed somewhat due to the slightly higher price level. Additional drilling, increased secondary recovery activity and a longer life for stripper wells will result in more production than under a lower price scenario. But it will be impossible to stop the slide under these economic conditions. A massive exploration and drilling effort would have to be launched in order to eliminate the decline. Replacing reserves is essential to the long-term viability of the domestic industry and to U.S. energy security. But worldwide economic forces do not presently support exploitation of these higher-cost domestic resources. If the energy security issue is of concern, then the government will have to take action to assist the industry by reducing the tax burden or eliminating other restrictions.

Something is also going to have to be done about the developing obstruction to exploration because of environmental concerns. Some serious economic analysis is going to have to be done to balance the twin goals of economic expansion and protecting the environment. It can't be accomplished by simply stopping all development. That could end up being disastrous.

Without some intervention, U.S. production is projected to decline throughout the forecast period. Crude and condensate production is expected to slide downward each year and fall to 6.98 million b/d by 1994. This is a drop of 10.2%, 795,000 b/d over the forecast period. Production in 1994 will be down 1.994 million b/d, 22.2%, from the 8.971 million b/d in 1985, before prices plummeted.

NGL and other hydrocarbons production is expected to move up marginally over the forecast period, increasing 100,000 b/d to 1.78 million b/d in 1994. Increased natural gas production and more efficient liquids extraction will boost output of NGL.

U.S. total liquids production is projected to fall to 8.76 million b/d in 1994, down 7.4% from 1989. By the end of the forecast period, U.S. total liquids production will have fallen to the lowest level since 1963.

Lower domestic production and increasing domestic demand will result in an ever-widening gap between domestic supply and demand. And this gap will have to be filled by imports.

Total industry imports, excluding crude imports for the Strategic Petroleum Reserve (SPR) are projected to increase 25.7% over the forecast period 1989–1994. Total industry imports will be up to 10.19 million b/d, an increase of 2.085 million b/d. This will be a record high.

By 1991, imports will be at a record high when they reach 8.975 million b/d. The previous annual record was 8.786 million b/d in 1977.

Crude oil imports will be up 32.9%, increasing to 7.710 million b/d in 1994. This will also be a record high for crude oil imports. The previous high was 6.594 million b/d also in 1977. Again the new record high will probably be reached by 1991.

With excess refining capacity available in the U.S., refiners prefer to import crude rather than products. Therefore, product imports are not expected to move up as rapidly. Product imports are forecast to move up 7.6% to 2.48 million b/d in 1994. This situation could change if foreign products become available at prices lower than domestic products. In that case, product imports could increase substantially.

With declining U.S. production and increasing imports, dependency on imported oil will increase markedly over the forecast period. Total imports as a percentage of domestic demand will move up from 46.2% in 1989 to 53.9% in 1994. This will be an all-time high. The previous high was 47.7% in 1977.

Net imports (total imports less exports) as a percentage of domestic demand will increase from 41.5% in 1989 to 49.3% in 1994. This will also be a record high. The previous high was 46.4% in 1977.

By the end of the forecast period, the U.S. will be more dependent on foreign oil than in the late 1970's. And the dependency will be on the rise with no end in sight.

The dependency will be on OPEC oil and will probably make the imports more vulnerable to supply disruptions and the economy more vulnerable to energy disruptions. Since non-OPEC production is not expected to increase over this period, the additional imports will have to come mainly from OPEC sources. Imports from OPEC countries are expected to increase to 60–70% of total U.S. crude imports by the end of the forecast period.

Stocks will not play a major role in the supply picture over the forecast period. Stocks are presently at close to a minimum level for operational efficiency. Expectations are that stocks will be increased as demand moves up over the forecast period.

THE OUTLOOK — U.S. SUPPLY

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
PETROLEUM BALANCE (thousand barrels/day)									
DEMAND:									
Domestic demand	17,283	17,560	17,830	18,070	18,410	18,660	18,910	+1,350	+ 7.7
Exports	815	820	830	840	850	860	870	+50	+ 6.1
Total demand	**18,098**	**18,838**	**18,660**	**18,910**	**19,260**	**19,520**	**19,780**	**+1,400**	**+ 7.6**
SUPPLY:									
Crude production	8,140	7,775	7,585	7,385	7,165	7,020	6,980	−795	−10.2
NGL & other hydrocarbons	1,678	1,680	1,700	1,720	1,740	1,760	1,780	+100	+ 6.0
Total liquids production	**9,818**	**9,455**	**9,285**	**9,105**	**8,905**	**8,780**	**8,760**	**−695**	**− 7.4**
Crude imports (ex. SPR)	5,055	5,800	6,230	6,630	7,135	7,460	7,710	+1,910	+32.9
Product imports	2,293	2,305	2,320	2,345	2,400	2,440	2,480	+175	+ 7.6
Total industry imports	**7,348**	**8,105**	**8,550**	**8,975**	**9,535**	**9,900**	**10,190**	**+2,085**	**+25.7**
Other supply	851	865	865	870	875	880	885	+20	+ 2.3
Total supply	**18,017**	**18,425**	**18,700**	**18,950**	**19,315**	**19,560**	**19,835**	**+1,410**	**+ 7.7**
TOTAL STOCKS: (million barrels)									
Crude stocks	330	340	345	350	360	365	370	+30	+ 8.8
Product stocks	707	715	725	735	745	755	770	+55	+ 7.7
Total industry stocks	**1,037**	**1,055**	**1,070**	**1,085**	**1,105**	**1,120**	**1,140**	**+85**	**+ 8.1**
SPR crude stocks	560	580	600	620	640	660	680	+100	+17.2
Total U.S. stocks	**1,597**	**1,635**	**1,670**	**1,705**	**1,745**	**1,780**	**1,820**	**+185**	**+11.3**
Industry stocks — days supply	60.0	59.2	60.0	60.0	60.0	60.0	60.3	+ 1.1	+ 1.9
IMPORT DEPENDENCY									
Net imports — % of domestic demand	42.5	46.2	48.0	49.7	51.8	53.1	53.9	+ 7.7	+16.7
Total imports — % of domestic demand	37.8	41.5	43.3	45.0	47.2	48.4	49.3	+ 7.8	+18.8
Crude imports — % of crude supply	38.3	42.7	45.1	47.3	49.9	51.5	52.5	+ 9.8	+23.0
CRUDE OIL PRICE ($/barrel)									
U.S. average wellhead	12.57	14.90	14.75	15.65	17.50	19.00	20.00	+5.10	+34.2
West Texas intermediate (posted)	15.52	18.30	18.10	19.20	21.45	23.30	24.50	+6.20	+33.9

U.S. SUPPLY—KEYS TO THE FUTURE

1. The price of crude oil at the wellhead oil will move up throughout the forecast period. The price will move up faster than the rate of inflation, but it will remain below the high prices of the 1980–1985 period. The price level will remain dependent upon international market conditions and OPEC actions.
2. The increase in prices will give a modest boost to U.S. exploration, drilling and production activities. However, the price rise will not be sufficient to stimulate a level of activity that would have a major impact on domestic production trends.
3. Production in the lower-48 states will continue to decline. The rate of decline will be slowed a bit by the increased drilling and other production activities.
4. Alaskan production has peaked and will also decline during the forecast period. The rate of decline will depend upon future exploration activities. And exploration activity will depend upon how the environmental issues are resolved.
5. Total U.S. crude production will fall to 6.98 million b/d in 1994, down 10.2% over the five years. This will be the lowest output since 1958.
6. Total imports will increase rapidly to fill the gap between increasing domestic demand and declining domestic production. Total imports will set record highs by 1991 and will be up 25.7% at 10.19 million b/d in 1994.
7. Dependency on imports will hit a new high in 1991 and will continue up to over 53% in 1994. Most of the increase will in imports will come from OPEC countries.
8. The domestic refining industry will be able to handle the increase in product demand without any major problems. The industry will continue to operate as efficiently as possible, minimizing stock levels and carrying costs, and trying to maximize the utilization rate.

CAPITAL EXPENDITURES

■

Investment in the U.S. oil and gas industry has gone through an extremely volatile period over the past 10–15 years. Capital and exploration expenditures in the oil and gas industry have taken some sharp swings over that period. The level of outlays has been closely tied to the amount of money flowing through the industry and the level of profitability. It has been most closely tied to the cash flow in the producing sector of the industry. And the cash flow has been determined to a great extent by the price level for crude oil and natural gas.

Prior to the 1970's there was relatively little price movement. Change in industry cash flow was determined by the change in the demand for crude, petroleum products and natural gas. And since this was an era of constantly rising demand, cash flow into the industry was tied to demand and also steadily rising. During this period investment decisions were based upon the expectations of increasing demand.

A change occurred in the 1970's. In the first part of the decade prices, demand and cash flow all moved up very rapidly. Capital expenditures followed and also moved up rapidly, particularly after the price hikes in 1973–1974 and 1978–1979.

The biggest change from the historical trend came about following the latter increase in prices. Demand hit a peak in 1978 and started to slide. This was unprecedented in the industry. The industry did not recognize that demand had hit a peak and was reacting to the huge jump in prices. Producers continued to push up prices and continued testing the market. Therefore, cash flow into the industry continues to move up. Capital expenditures followed prices and cash flow. But at that time, the increase was no longer tied to an industry with increasing demand.

Prices and capital spending did not peak until 1981. Both prices and spending exhibited a delayed reaction to the downturn in consumption of petroleum products.

Since 1981, U.S. oil and gas industry capital expenditures have been falling, generally following the trend in crude oil and natural gas prices. However, another shift in direction may be occurring: capital outlays moved up slightly in 1988 on the strength of industry profits and a modestly optimistic outlook.

U.S. CAPITAL SPENDING

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	(Million $)									
Drilling-Exploration	21,926	31,789	43,193	40,965	28,193	28,290	26,596	13,552	10,125	10,487
Production	4,490	6,191	7,984	7,144	5,531	5,590	5,217	3,066	2,046	2,088
OCS lease bonus	4,590	4,205	6,599	3,800	5,749	4,037	1,488	187	497	1,217
Subtotal	**31,006**	**42,185**	**57,776**	**51,909**	**39,473**	**37,917**	**33,301**	**16,805**	**12,668**	**13,792**
Refining	2,735	3,159	5,131	5,775	4,142	2,914	2,992	2,073	2,180	2,874
Petrochemicals	2,355	2,805	2,792	2,031	1,112	1,215	1,493	1,357	1,248	1,962
Marketing	851	1,276	1,619	1,349	1,614	2,221	2,611	1,634	1,810	2,525
Crude & products pipelines	1,509	1,777	2,052	1,121	2,456	1,689	1,137	435	733	400
Gas pipelines	1,491	3,642	4,947	5,179	4,707	3,971	2,084	1,309	1,556	1,659
Other transportation	583	804	895	515	456	386	458	380	310	416
Miscellaneous*	3,700	5,022	7,731	7,760	4,567	4,347	3,706	3,258	3,180	3,457
Subtotal	**13,224**	**18,485**	**25,167**	**23,730**	**19,054**	**16,743**	**14,481**	**10,446**	**11,017**	**13,293**
Total	**44,230**	**60,670**	**82,943**	**75,639**	**58,527**	**54,660**	**47,782**	**27,251**	**23,685**	**27,085**

*Includes mining and other energy

Source: Oil & Gas Journal

U.S. CAPITAL SPENDING (CONSTANT DOLLARS)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	(Million $)									
PPI*	**2.356**	**2.667**	**2.934**	**2.993**	**3.031**	**3.103**	**3.088**	**2.998**	**3.077**	**3.246**
Drilling & exploration	9,306.5	11,830.7	14,721.5	14,784.8	9,301.6	9,117.0	8,612.7	4,520.3	3,290.5	3,230.7
Production	1,905.8	2,304.1	2,721.2	2,900.4	1,824.8	1,801.5	1,689.4	1,022.7	664.9	643.3
OCS lease bonus	1,948.2	1,564.9	2,249.1	1,332.1	1,896.7	1,301.0	481.9	62.4	161.5	374.9
Subtotal	**13,160.4**	**15,699.7**	**19,691.9**	**19,017.3**	**13,023.1**	**12,219.5**	**10,784.0**	**5,605.4**	**4,116.9**	**4,248.9**
Refining	1,160.9	1,175.7	1,748.8	1,573.7	1,366.5	939.1	968.9	691.5	708.5	885.4
Petrochemicals	999.6	1,043.9	951.6	524.6	366.9	391.6	483.5	452.6	405.6	604.4
Marketing	361.2	474.9	551.8	446.7	532.5	715.8	845.5	545.0	588.2	777.9
Crude & prod pipelines	640.5	661.3	699.4	441.0	810.3	544.3	368.2	145.1	238.2	123.2
Gas pipelines	632.9	1,355.4	1,686.1	2,028.1	1,553.0	1,279.7	674.9	436.6	505.7	511.1
Other transportation	247.5	299.2	305.0	172.1	150.4	124.4	148.3	126.8	100.7	128.2
Mining & other energy	658.3	945.7	1,442.7	1,177.4	579.7	606.8	401.2	426.0	399.4	358.9
Miscellaneous	912.1	923.3	1,192.2	1,431.3	927.1	794.1	798.9	660.8	634.1	706.1
Subtotal	**5,612.9**	**6,879.4**	**8,577.7**	**7,795.0**	**6,286.4**	**5,395.7**	**4,689.4**	**3,484.4**	**3,580.4**	**4,095.2**
Total	**18,773.3**	**22,579.1**	**28,269.6**	**26,812.3**	**19,309.5**	**17,615.2**	**15,473.4**	**9,089.8**	**7,697.3**	**8,344.1**

*Producer's Price Index (1967 = 1.00)

REVIEW

Over the past 10–15 years, the price of crude oil has led U.S. oil and gas industry capital expenditures through a cycle of huge amplitude. For the industry it has been a boom-bust period of historic proportions.

THE RAPID RISE IN SPENDING. Starting in the late 1970's, rapidly rising prices led the way to a huge increase in investment. The average wellhead price of domestic crude oil went up from $9.00/bbl in 1978 to $31.77/bbl in 1981. This was a jump of $22.77/bbl, 253%, in just three years. The average cost of imported crude oil increased from $13.30/barrel in 1978 to $35.10/barrel in 1981, an increase of 163.9%. The average refiner acquisition cost of crude oil, both domestic and imported, increased from $12.46/barrel in 1978 to $35.24/barrel in 1981, an increase of 182.8%.

It should be noted that in 1978 there were still price controls on some domestic U.S. production, and therefore the average domestic price remained well below the world price until controls were lifted.

Over this short three year span the total value of U.S. crude production at the wellhead went up from $13.1 billion in 1973 to $28.6 billion in 1978. It then jumped to $99.4 billion in 1981. This came about even though U.S. crude production in 1981 was down 6.9% from 1973 and down 1.6% from 1978.

Just based on wellhead value from domestic production, industry revenues had moved up

$86.3 billion from 1973 and up $70.8 billion from three year earlier 1978. When refined product sales are taken into consideration, the increased revenue is substantially greater. Product prices moved up along with crude prices, also substantially increasing the revenue flowing to the oil industry.

In response to this tremendous surge in industry revenue, industry capital spending shot up. Over the same three-year span, total U.S. oil industry capital spending went from $29.2 billion to $82.9 billion, an increase of 184.1%.

Over this upswing portion of the cycle, 1978 through 1981, exploration, drilling and production spending (including OCS lease bonus payments) increased from $20 billion to $57.8 billion, an increase of 189.2%. Spending on exploration and drilling activities alone increased from $15.1 billion in 1978 to $43.2 billion in 1981, an increase of 186.4%. Production outlays increased 154.9% to $8.0 billion in 1981. And OCS lease bonus payments by the industry jumped to $6.6 billion in 1981, up from $1.8 billion in 1978.

With these lofty prices for crude oil and rising natural gas prices, there were many more production prospects that were economical for development. Even very marginally producing wells could be economically justified and considered potentially profitable.

Capital outlays were also being driven up by the expectations, at that time, of substantially higher price in future years. As a result of these optimistic projections, in addition to much higher wellhead revenues, there was a lot of outside capital flowing into exploration and production activity. With higher prices, the cash flow into the industry moved up, and this was combined with substantially more outside funds available for investing. With adequate funds available, companies were also expanding and upgrading other aspects of their operations: refining, petrochemicals, marketing and transportation. In addition, some companies were diversifying into related industries, such as mining, and into other attractive activities.

Spending for all of the other segments of the industry also increased. Outlays for refining, marketing, transport, etc., moved up from $9.2 billion in 1978, to $25.2 billion in 1981, an increase of 173.2%.

THE FALL IN SPENDING. Demand peaked in the U.S. in 1978 and prices peaked in March of 1981. These two events started a slide that lasted for several years. The drop in prices and demand resulted in a large reduction in the cash flow into the U.S. oil and gas industry and therefore a reduction in the funds available for capital and exploration spending.

As a result, U.S. oil and gas industry capital and exploration expenditures plummeted from the lofty levels of the 1981 and 1982 peak boom years. Capital spending by U.S. oil companies peaked in 1981 at $82,943 million. It fell to $80,249 million in 1982 and then dropped sharply to $58,527 million in 1983. Spending dropped in 1984 to $54,660 million and slipped again to $47,782 million in 1985. Natural gas prices continued to move up until 1984 and provided a small offset to declining crude oil revenues But this wasn't sufficient to stem the drop in cash flow.

When prices plummeted in 1986, capital spending followed, dropping precipitously to an estimated $27,250 million. Prices moved up a bit in 1987, but investors were still wary of the crash the previous year. Capital spending slipped to $26,597 million. Spending in 1987 was at the same level as ten years earlier, 1977, when outlays totaled $26,691 million. Spending in 1987 was down $56,346 million from the peak in 1981.

Total spending moved up in 1988 for the first time since the 1981 peak year. A rise in oil prices in 1987 and increased profitability in 1988 stimulated additional investment. Spending increased to $27,085 million.

During the years of declining outlays, 1981-1987, total exploration drilling and production outlays accounted for $45.1 billion of the decline. Spending in this sector of the business fell from $57.8 billion in 1981 to an estimated $12.7 billion in 1987. This was a drop of 78.1% in the six years. Outlays in this area fell $16.5 billion in 1986 alone.

Spending on other activities also fell dramatically, but not as rapidly as exploration and production. All of the other capital spending together fell, 56.2% from $25,167 million in 1981 to $11,017 million in 1987, a drop of $14,150 million.

Capital spending fell at about the same rate as crude prices. The average wellhead price of domestic crude oil fell from $31.77/bbl in 1981 to $12.51/bbl in 1986, a decline of 60.6%. Natural gas prices also began to fall in 1984 and the average wellhead price in 1986 was down 29.7% from the peak. Over this same period, there was also a drop in demand for petroleum products and natural gas, so the cash flow impact on individual companies was greater than reflected in just the price change.

Crude prices moved up in 1987 but slumped again in 1988. Natural gas prices continued to fall through 1987 and into 1988. There has not been any recent surge in cash into the industry that would stimulate a large increase in capital spending.

INTERNATIONAL SPENDING – U.S. FIRMS

	1983	1984	1985	1986	1987	1988	1989	1990
					(Million $)			
Exploration-Production								
Drilling-Exploration	5,622	3,455	5,238	3,590	3,679	3,586	3,990	4,650
Production	2,940	1,831	2,688	2,322	2,472	2,879	3,035	3,520
Subtotal	**8,562**	**5,286**	**7,926**	**5,912**	**6,151**	**6,465**	**7,025**	**8,170**
Other								
Refining	696	808	959	716	471	822	901	920
Petrochemicals	467	219	245	360	436	589	761	800
Marketing	638	640	932	878	1,054	1,214	1,423	1,450
Pipelines	141	148	215	139	111	136	138	140
Other transportation	162	24	154	43	61	151	103	120
Mining & other energy	869	690	816	655	336	200	442	460
Miscellaneous	650	278	486	211	217	410	247	260
Subtotal	**3,623**	**2,807**	**3,807**	**3,002**	**2,686**	**3,522**	**4,015**	**4,150**
Total	**12,185**	**8,093**	**11,733**	**8,914**	**8,837**	**9,987**	**11,040**	**12,320**

Source: Oil & Gas Journal

SPENDING AND PROFITS.

Corporate investment decisions are probably made with a closer eye to profits than to prices. Although industry capital spending followed crude prices closely, the spending decisions were more probably based on estimated profitability. However, available funds also influence spending decisions. And crude and product prices were a major determinant of cash flow over the past ten years. So prices probably were a major influencing factor in the investment decisions.

The level of profits is determined by many factors. So although capital spending tends to follow profits, the relationship between the two in any given year can fluctuate greatly.

For the *Oil & Gas Journal* group of 25 large integrated oil companies, worldwide capital and exploration expenditures as a percentage of net income ranged from 177.5% in 1980 to 383.2% in 1987. The average from 1978 through 1988 was 243.4%.

The level of investment in any given year was dependent upon the profit picture for the individual company at that point in time. It was also influenced by the available funds and the companies outlook for the industry. Overall, this group of companies has maintained a high level of capital investment relative to profits, despite the downturn in the industry. Their planning horizons tend to be relatively long range and they invest for the future.

But with the low prices and the outside threat of takeovers recently, the companies have been forced to adhere more closely to the short-range market philosophy of the investment community. The longer-range outlook might pay larger future returns, but most investors aren't looking very far into the future.

In addition, many oil companies have been forced into reorganization to prevent hostile takeovers and dismemberment. The fall in prices and oil company revenues rapidly changed the perception that outside investors had of the future potential of the oil industry. Outside interests saw a profit opportunity in forcing rapid restructuring. This has resulted in a wave of mergers, stock repurchase plans and other moves to fend off hostile takeovers. The result for many companies has been a substantial additional increase in debt. This has further reduced funds available for reinvestment.

OGJ GROUP* PROFITS AND CAPITAL SPENDING

	Net income (Million $)	Capital & exploratory expenditures (Million $)	Capital & exploration expenditures % of net income
1978	13,779.0	42,265.0	306.7
1979	23,130.0	53,261.0	230.3
1980	29,326.8	52,065.0	177.5
1981	28,205.4	66,895.8	237.2
1982	23,079.7	60,357.0	261.5
1983	22,325.5	45,584.1	204.2
1984	20,078.1	51,422.8	256.1
1985	15,801.5	50,907.5	322.2
1986	10,893.7	33,620.2	308.6
1987	8,370.4	32,079.3	383.2
1988	21,835.8	39,261.9	179.8
Total 1978-1988	**216,825.9**	**527,719.6**	**243.4**

*Oil & Gas Journal group of 25-28 major oil companies.

Source: Oil & Gas Journal

In addition, companies have been restructuring since the peak period in other ways aimed at increasing profitability. They have been cutting staff levels, cutting operating costs and shedding surplus facilities. They have been somewhat preoccupied with these activities at the expense of new investing.

The exploration, drilling and production segments of the domestic industry have been particularly hard hit by the lower prices. The lower prices have markedly reduced the wellhead revenues from crude oil and natural gas production. This has diminished the funds available for reinvestment in drilling activity. In addition, many companies have had to use available funds to reduce the debt burden left over from the boom period.

During the boom, the expectation of higher oil prices not only increased the flow of outside capital, but also encouraged a number of companies to increase their debt to expand their operations. As prices fell, the debt became a prohibitive burden. The necessity to repay the debt with funds from lower valued oil has severely restricted the investment capability of many firms.

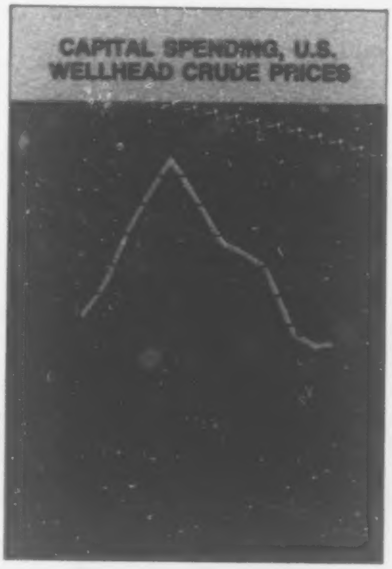
With oil prices down and pessimistic future price prospects, the flow of outside capital into the industry dried up. The glamour left oil investing, and the highly speculative funds that flowed into the industry in the 1979-1982 period, in anticipation of a potential high rate of return, are now being invested elsewhere.

As a result of the sharp drop in funds available to the industry, the wellhead revenue reinvestment ratio, an indicator of the attractiveness of oil investing, fell to one of the lowest levels on record. This ratio measures the percentage of total wellhead revenues that are reinvested in drilling activity. A drop in this ratio indicates a loss of confidence in investing in industry exploration.

Drilling rig activity followed the drop in the reinvestment ratio. Rig activity in 1986 fell to the lowest weekly level ever recorded; at least the lowest level since the Hughes Tool Company started counting active rigs on a regular basis. The rig activity has remained low and will average only 850 active rigs in 1989, the lowest level since the war effort depressed drilling activity in 1942.

It appears that a ten year cycle in U.S. oil industry investment has been completed and the industry is back to the point it started at in 1977. The average wellhead price for domestic crude was $15.41/bbl in 1987 and $12.57/bbl in 1988. The average landed cost of crude oil imports in 1977 was $14.38/bbl. Domestic prices were under controls in 1977 and therefore are not a good comparison. Total capital and exploration spending in 1988 was $26,355 million. Total spending in 1977 was $26,691 million. The industry turned up in 1978 and there are presently some positive signs. However, any enthusiasm about the future has to be tempered since it is doubtful that there will be as rapid an increase in spending as ten years earlier.

NON-U.S. SPENDING. With the sharp drop in prices there has been a shift in spending to the lower cost areas outside the U.S. The U.S. international companies have been spending a greater portion of their capital budgets outside the U.S. in recent years. International, non-U.S. spending by a group of U.S. companies has been on the rise since 1987. Spending outside the U.S. by this group has risen from $8,837 million in 1987 to an estimated $11,040 million in 1989. This is an increase of 24.9% over the past three years. Plans call for this group to boost spending to $12,320 million in 1990.


CAPITAL SPENDING, U.S. WELLHEAD CRUDE PRICES

These companies are finding investments in lower cost non-U.S. areas to be more attractive than domestic investment. In addition, many non-OPEC countries are offering better investment terms to companies willing to explore in their country. When prices dropped some of these countries saw investment dry up in their oil industries. The international companies did not find investing very profitable under the stringent financial terms that existed in past years.

Total worldwide petroleum industry capital spending fell off sharply after prices plummeted in 1986. Total investment fell from $91 billion in 1985 to $60.56 billion in 1987. When prices rebounded in 1987, it stimulated spending the following year and total capital spending increased slightly to $63.89 billion. But prices fell in 1988 and spending dipped in response in 1989 to $60.39 billion.

OUTLOOK

With the outlook for the industry improving, this may prove to be the start of a new investment cycle. However, it is doubtful that the upswing portion of the cycle will be as volatile as the one that started ten years ago. Prices are still low and periodically have been depressed due to OPEC over-production. And at present the most optimistic expectation is that prices will move up modestly over the forecast period. Demand for petroleum products is on the rise, competition from other fuels will hold down the rate of increase.

The last few years have been a period of adjustment for companies in the industry. It was necessary for most companies to restructure and cut costs sharply. This led to a reduction in capital investment. However, the effects of the cost cutting are now beginning to show up in improved profits and investments. In addition, as the companies reduce the heavy debt load brought on for restructuring, investment can be increased. In addition, the lower debt load and improved profits should attract additional outside funds into the industry.

However, it is not expected that there will be anything close to the surge in spending that occurred during the 1980–1982 period. Instead, capital expenditures will closely follow revenue and price movements, along with economic activity, and energy and oil demand.

Capital spending in the U.S. oil and gas industry will move the way of prices and profits over the forecast period. Total outlays are projected to increase 63.6% by 1994. Spending in 1994 will total $44.035 billion. This will be up $17 billion from 1989. Spending is expected to increase much faster than prices. Spending is at a relatively depressed level now, so the rate of increase will be much greater. Domestic crude oil prices are projected to move up 34.2% by 1994. Natural gas prices will increase 35.3%, and motor gasoline pump prices will be up 20.3%.

U.S. domestic expenditures for exploration and production activities will also tend to follow the movement of oil prices over the forecast period, but are expected to increase much faster. Spending in this sector of the domestic industry will increase steadily and rapidly throughout the forecast period. The reinvestment ratio for the industry is quite low at present. Both cash flow directly into the industry and the percentage reinvested are expected to increase during the next five years. Spending on exploration, drilling, production and OCS lease bonuses is forecast to increase 104.8% over the five year forecast period. Spending will increase to $26.305 billion in 1994, up $13.462 billion from 1989.

Spending for just the exploration and drilling segment is projected to increase 105.4%, up $10.782 billion, to $21.010 billion in 1994. The expected price rise for crude oil and natural gas will stimulate drilling activity. And as prices move up, some outside investment funds will return to the industry. This will be particularly true in the later years if prices move up more rapidly.

The independent sector of the U.S. domestic industry does the majority of the drilling, but relies heavily on outside investment funds. When prices appear a bit more certain, investors will return and activity and investment by the independents are expected to increase. Some needed additional funds will flow in to increase exploration and drilling activity.

Drilling costs have fallen sharply from their peak in 1982. This has improved the economics of exploration and drilling activity. With the large inventory and capacity surplus in the drilling and service, and supply industries, drilling costs have been held down. Drilling costs are expected to start moving up over the forecast period, but they are not expected to move up as rapidly as oil and natural gas prices. Therefore, as prices move up the economics of exploration will improve even more and this should stimulate additional drilling activity.

It may also become obvious in political circles that there is a necessity to replace depleting domestic oil and gas reserves. This may result in more favorable tax treatment for the industry. This would also give a boost to exploration and drilling activity as well as investment.

Spending on production facilities will follow drilling activity. Outlays will increase 105.6% over the forecast period, moving up to $4.245 billion in 1994.

Outer continental shelf (OCS) lease bonus payments fell sharply from $6,599 million in 1981 to $1,488 million in 1985. Then in 1986 they almost dried up completely, falling to only $187 million. They moved up in 1987 to $497 million and to 1,217 million in 1988. It is expected that OCS bonus payments will increase over the forecast period as the economics of the available offshore leases improves with the rising prices. It is expected that they will move back up to levels more comparable to the mid 1970's, by the end of the forecast period. The projection is for OCS bonus payments to rise to $1.05 billion in 1994.

Spending on downstream facilities and other projects will not increase as rapidly over the forecast period, but spending will move up as higher prices make more funds available for investing. Outlays will increase 26% to $17.73 billion in 1994. This is an increase of $3.657 billion.

Refining and petrochemical investments remained at relatively high levels, even though demand for petroleum products fell for five consecutive years, 1978-1983. High levels of investment were viewed as essential for improved future profitability. Refiners cut back on overall distillation capacity, but continued to invest in upgrading facilities. There is higher profitability in increased yields of higher priced light products. Refiners also wanted the flexibility to use heavier, cheaper crudes as feedstock to cut costs. This also required additional investment.

Much of the excess capacity in the U.S. has been eliminated. But the domestic refining industry is still quite competitive and there is more competition from foreign products. The increase in demand, particularly for motor gasoline, has returned a measure of profitability to refining. It is expected that capital expenditures will move up over the forecast period as refiners try to continue to improve facilities and their profit margins.

Investment in the petrochemical industry will concentrate on improving efficiency and reducing costs in the face of increasing foreign competition. The petrochemical industry set record profits in 1988 and 1989 and sales are increasing markedly along with the growing economy. Needed investments are expected to be made to expand and upgrade facilities as required.

Total spending for refining and petrochemical operations is projected to increase 23.8% to $7.56 billion in 1994.

Capital spending for marketing facilities is expected to continue to move up throughout the forecast period. The high level of competition in the marketing sector has stimulated investment as companies strive to maintain and/or gain market share. Spending is expected to increase 11.5% to $2.87 billion in 1994.

Transport spending for pipelines, tankers and trucks will increase 73.3% over the forecast period, moving up $1.438 billion to $3.4 billion in 1994.

Spending by U.S. oil companies for mining and other activities is expected to move up more moderately over the forecast period than other categories of spending. A number of companies have sold or discontinued their mining and metals operations. Outlays will increase 21.5% to $1.25 billion in 1994.

In the exploration and production sector, some of the larger international companies are shifting a large proportion of their spending overseas. A sampling of spending plans for a group of U.S. companies show international expenditures will be up 11.6% in 1990 to $12.32 billion. Exploration drilling and production outlays are projected to be up 16.3% at $8.17 billion.

This is indicative of an expected shift to more investment in international activities. With lower cost, more profitable exploration and production activity possible overseas, U.S. companies are diverting more of their investments to international operations than in past years. The lower crude prices are reducing the revenues flowing into many non-OPEC producing countries. Or the countries are burdened with debt and can't afford the imports even at the lower prices. Therefore, it is now possible to negotiate some attractive exploration agreements.

WORLDWIDE PETROLEUM INDUSTRY CAPITAL SPENDING

	1985	1986	1987	1988	1989	1990
			(Million $)			
U.S. AND CANADA:						
Crude Oil and Natural Gas	50,330	29,150	26,800	27,730	25,480	32,400
NGL Plants	860	510	450	500	550	600
Refineries	3,540	2,950	2,700	3,340	3,720	3,790
Total North America	**54,730**	**32,610**	**29,950**	**31,570**	**29,750**	**36,790**
MEXICO AND CENTRAL AND SOUTH AMERICA:						
Crude Oil and Natural Gas	7,010	6,930	6,080	6,360	5,400	6,090
Refineries	3,490	2,260	2,200	2,100	1,900	2,000
Total Central & S. America	**10,500**	**9,190**	**8,280**	**8,460**	**7,300**	**8,090**
WESTERN EUROPE:						
Crude Oil and Natural Gas	11,620	11,550	9,300	10,140	9,300	10,670
Refineries	1,650	1,480	1,400	1,300	1,300	1,300
Total Western Europe	**13,270**	**13,030**	**10,700**	**11,440**	**10,600**	**11,970**
MIDDLE EAST AND AFRICA:						
Crude Oil and Natural Gas	4,010	3,160	2,630	2,820	2,750	3,050
Refineries	980	940	900	800	800	850
Total Middle East & Africa	**4,990**	**4,100**	**3,530**	**3,620**	**3,550**	**3,900**
FAR EAST AND AUSTRALASIA:						
Crude Oil and Natural Gas	4,400	3,680	3,750	4,300	4,400	4,800
Refineries	1,520	1,860	1,800	1,750	1,700	1,800
LNG Plants	590	1,230	900	950	1,000	1,050
Total Far East & Australasia	**6,510**	**6,770**	**6,450**	**7,000**	**7,100**	**7,650**
FREE WORLD						
Crude Oil and Natural Gas	77,370	54,470	48,580	51,350	47,420	57,010
NGL Plants	860	510	450	500	550	600
Refineries	11,190	9,480	9,000	9,290	9,420	8,740
LNG Plants	590	1,230	900	950	1,000	1,050
Tankers	990	1,580	1,650	1,800	2,000	2,500
Total Free World	**91,000**	**67,270**	**60,580**	**63,890**	**60,390**	**70,100**

THE OUTLOOK — CAPITAL EXPENDITURES

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
U.S. DOMESTIC OIL INDUSTRY CAPITAL EXPENDITURES (Million $)									
Exploration & drilling	10,487	10,228	11,950	14,100	16,215	18,500	21,010	+10,782	+105.4
Production	2,088	2,065	2,410	2,850	3,275	3,735	4,245	+2,180	+105.6
OCS lease bonuses	1,217	550	750	825	910	980	1,050	+500	+90.9
Subtotal	**13,792**	**12,843**	**15,110**	**17,775**	**20,400**	**23,215**	**26,305**	**+13,462**	**+104.8**
Refining	2,874	3,179	3,340	3,420	3,600	3,750	3,900	+721	+22.7
Petrochemicals	1,962	2,927	3,220	3,380	3,480	3,550	3,660	+733	+25.0
Marketing	2,525	2,574	2,630	2,680	2,750	2,810	2,870	+296	+11.5
Pipelines	2,059	1,420	1,830	2,100	2,280	2,340	2,400	+980	+69.0
Other transportation	416	542	600	700	800	900	1,000	+458	+84.5
Mining and other energy	1,165	1,029	1,100	1,200	1,250	1,250	1,250	+221	+21.5
Miscellaneous	2,292	2,402	2,450	2,500	2,550	2,600	2,650	+248	+10.3
Subtotal	**13,293**	**14,073**	**15,170**	**15,980**	**16,710**	**17,200**	**17,730**	**+3,657**	**+26.0**
Total	**27,085**	**26,916**	**30,280**	**33,755**	**37,110**	**40,415**	**44,035**	**+17,119**	**+63.6**
OFFSHORE SPENDING: (Million $)									
Exploration-Drilling-Production	3,504	3,639	4,325	5,025	5,625	6,260	7,100	+3,461	+95.1
PRICES:									
Crude oil (Av. U.S. wellhead—$/barrel)	12.57	14.90	14.75	15.65	17.50	19.00	20.00	+5.10	+34.2
Natural gas (Av. U.S. wellhead—$/mcf)	1.71	1.70	1.70	1.80	2.00	2.15	2.30	+0.60	+35.3
Motor gasoline (Av. all types—$/gallon)	0.963	1.085	1.075	1.115	1.180	1.245	1.305	+0.220	+20.3

Overseas downstream investments will not move up as rapidly. The worldwide industry has a much larger refining and petrochemical overcapacity than the U.S., and new facilities in the Middle East have further added to the problem. Some investment will be shifted from U.S. domestic activities to the international scene, but the funds will be selectively invested in the most profitable sectors of the business.

Total spending by the worldwide petroleum industry is projected to move up in 1990 in anticipation of future profit improvement in the industry. Total spending is projected to be up 17.4%, an increase of $10.51 billion, to $70.9 billion for 1990.

CAPITAL EXPENDITURES—KEYS TO THE FUTURE

1. Industry restructuring is continuing, but a lot has already been done, and the industry as a whole is more profitable. Companies are now in a better position to take advantage of industry investment opportunities.
2. Increased prices for crude oil, natural gas and petroleum products, coupled with increased demand, will give a substantial boost to industry cash flow. A combination of improved efficiency from restructuring and increased cash flow should also boost profits.
3. The increased cash flow and improved profits will result in increased capital and exploration expenditures over the forecast period.
4. Exploration and drilling expenditures will move up faster than prices as the economics improves. Some outside money will flow back into the industry, due to the improved profitability.
5. Increased profits will lead to increased investment in the refining and petrochemicals sectors.
6. Some U.S. companies will shift a greater portion of their investment overseas, to take advantage of attractive international exploration and drilling opportunities.
7. Higher prices and increased demand will boost worldwide oil industry spending substantially at the start of the forecast period. It will continue to move up over the five years.

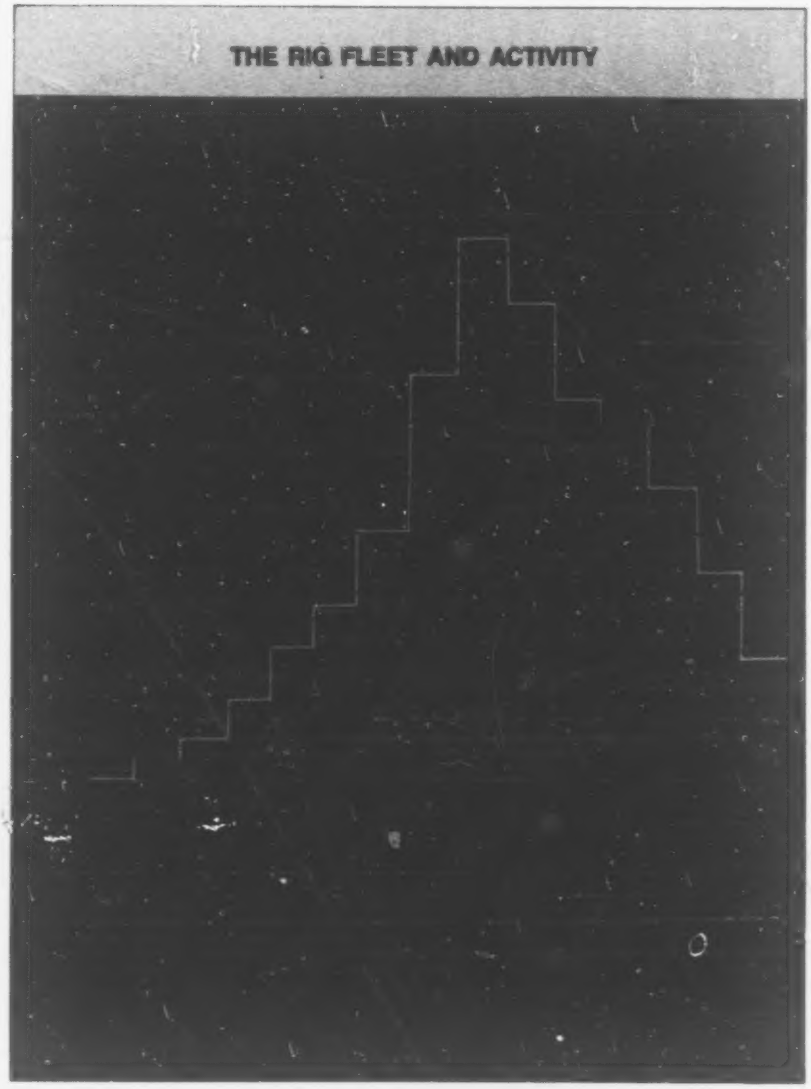
EXPLORATION, DRILLING AND PRODUCTION

The exploration, drilling and production sector of the U.S. oil and gas industry has been languishing in the trough of its recent business cycle for the last three years. Activity levels in exploration and drilling are at all-time lows. And there are no signs of an immediate recovery. But extreme cycles in activity seem to be the norm rather than the exception for the exploration and drilling sector of the U.S. oil and gas industry. And therefore it is difficult to accurately predict its future course. It may remain in a depressed state for some time or it may be entering into a new expansion cycle.

This sector of the industry has gone through some extreme cycles during its history. But none of the previous cycles was as pronounced as the present one. During this cycle exploration and drilling activity in the U.S. went through both a record high level of activity and hit a record low. And the time span from record high to record low was only a short period of 4.5 years.

Activity in this area of the industry has closely followed the price of crude oil and natural gas. The relationship between activity and price has been closer in this sector than in any other segment of the industry.

It has been an interesting period in the "oil patch." But the excitement is


THE RIG FLEET AND ACTIVITY

not completely over. This segment of the industry has been amazingly adept at rapidly adjusting to shifts in economic conditions.

At the present it is difficult to determine if the industry is poised at the start of a new upward leg of another cycle or is caught in an extended trough. There have been modest signs of recovery, but there have also been indications of a continued recession in activity.

One thing that is certain is that crude oil and natural gas will be major energy sources for a long time into the future. And exploration and drilling are the only way to find new domestic reserves.

REVIEW

RIG COUNT. The number of active rotary drilling rigs is a key indicator of activity in the upstream portion of the U.S. domestic oil and gas industry. Through the recent boom and bust cycle the number of active drilling rigs has closely followed the price of crude oil. And it appears that this close relationship will continue for the foreseeable future.

When the price of crude oil moved up rapidly between 1971 and 1981 the rig count followed. The number of active rotary drilling rigs increased from an annual average of 976 rigs in 1971 to a peak of 3,970 rigs in 1981. This was an increase of 2,994 active rigs, 306.8%. The amount of domestic drilling activity quadrupled over that eleven-year span. The record count for any one week was reached the last week of December 1981, at 4,530 active rigs.

During that period the rig count was chasing the rapidly increasing

WELL COMPLETIONS, FOOTAGE, AND ACTIVE RIGS

	Active rigs	Total well completions*	Total footage*	Average ft./well	Avg. wells per rig	Avg. ft. per rig
1974	1,471	33,037	153,776,399	4,655	22.46	104,539
1975	1,660	38,884	181,039,993	4,656	23.42	109,060
1976	1,656	40,940	187,289,586	4,575	24.72	113,098
1977	2,001	45,855	215,695,878	4,704	22.92	107,794
1978	2,255	50,061	238,386,248	4,762	22.20	105,715
1979	2,176	51,890	243,685,430	4,696	23.85	111,988
1980	2,910	69,486	311,444,837	4,482	23.88	107,026
1981	3,970	89,234	406,520,453	4,556	22.48	102,398
1982	3,105	83,889	375,382,919	4,475	27.02	120,896
1983	2,232	75,738	316,617,464	4,180	33.93	141,854
1984	2,428	85,359	368,336,310	4,315	35.16	151,704
1985	1,980	70,806	316,778,000	4,474	35.76	159,989
1986	964	39,118	177,977,000	4,550	40.58	184,623
1987	936	35,732	162,101,000	4,537	38.18	173,185
1988	936	32,266	153,693,000	4,763	34.47	164,202

*Excludes service and stratigraphic wells and core tests.

Source: American Petroleum Institute and Baker Hughes Inc.

price of oil. Back in 1971, the average U.S. wellhead price for crude oil was $3.39/bbl. This moved up sharply in the 1970's and reached a high of $34.70/bbl in March 1981. At that lofty price almost any producing well was economic, and therefore drilling activity proliferated.

But prices began to slip after March 1981. There was not an immediate response in rig activity, but starting in January 1982 the rig count finally followed. And the rig count fell precipitously. The active rig count fell for ten consecutive months, hitting a 1982 low of 2,379 in October, and averaging 3,105 active rigs for the year. There was a slight seasonal upturn at the end of the year, but then the count continued its decline. The number of active rigs fell to 1,807 in April 1983. This was down 2,723 active rigs from the peak, and a drop of 60.1%. The annual average for 1983 was 2,232 active rigs, down 1,738 rigs, 43.8% below the peak.

Prices seemed to stabilize at around $26/bbl in 1984. And as a result there was a slight upturn in rig activity in 1984. The rig count averaged 2,428 for the year. But the price of crude oil slid further in 1985, to $24/bbl, and the rig count also fell, averaging 1,980 for the year.

Excess worldwide production brought about a precipitous crash of crude prices in 1986. And this resulted in a sharp drop in the active rig count, down to a record low. The rig count had averaged 1,950 active rigs in the month of December 1985. With the crude oil price in a "free fall" the rig count took a precipitous fall, dropping to a record average monthly low of 686 active rigs in July 1986. The record weekly low was recorded July 14, 1986 at 663 rigs. This was a drop of 3,867 active rigs, 85.4%, in 54 months. The year ended with the lowest annual average rig count since 1942, at 964 active rigs. In 1942 the count was depressed, because manufacturing activities were focused almost solely on producing for the military effort.

Crude oil prices dipped below $10/bbl in 1986. The low point was July 1986 when the average wellhead price for U.S. crude oil hit $9.25/bbl. For the year, prices averaged $12.51/bbl, down 48.1% from the previous year, and down 60.6% from the peak year.

The decline in crude oil prices was the main reason for the sharp drop in rig activity. But there were a couple of factors that contributed to the magnitude of the decline.

Not only did prices begin to slide in 1981, but by the next year, the long range outlook for oil prices had changed dramatically. During the expansion phase of the boom, projections called for oil prices to move up to $50/bbl and higher in the near future. And a lot of the investment was based on these price expectations. This outlook prevailed some time even after prices had begun to fall.

Prices turned around in February and March 1981. The U.S. refiner acquisition cost of imported crude peaked in February 1981 at $39/bbl. Domestic refiner acquisition cost and wellhead price peaked in March 1981, at $36.97 and $34.70, respectively. Analysts were not immediately aware of the turn around or did not recognize it as a turning point. Aggregate price data prepared by the government was not immediately available to warn of the change in direction in crude oil prices. It often takes 3–5 months for government agencies to collect, aggregate and publish this information.

At that early date few analysts or investors picked up on the implications of the early 1981 drop in prices. Any leveling of prices was considered temporary or regional. And, at the prevailing prices, even though slightly lower, many projects were still very attractive. So the drilling boom continued throughout 1981 and into 1982, even as crude prices fell.

As prices continued the slide, prospects diminished substantially for any future appreciation of the value of crude oil—at least for the more immediate future period that is used for making investment decisions. Therefore, outside investments declined. Part of the boom had been financed by speculative investing, which tends to chase the highest expected rate of return. With the drop in prices and a pessimistic outlook much of that investment money moved away from the petroleum industry.

Another reason for the rapid and extremely deep cut in drilling activity was the accumulation of debt by oil operators and producers. Expectations that crude oil prices would reach $50/bbl and continue to climb had stimulated the surge in drilling activity. With an industry consensus supporting this outlook for higher prices, investment funds flowed into the drilling industry, and banks actively sought investors in oil exploration projects. Funds were available and the "expert" analysis supported investment, even if it required substantial debt. Everyone wanted to drill as many prospects as possible as fast as possible and many companies became burdened with debt.

When prices fell, funds had to

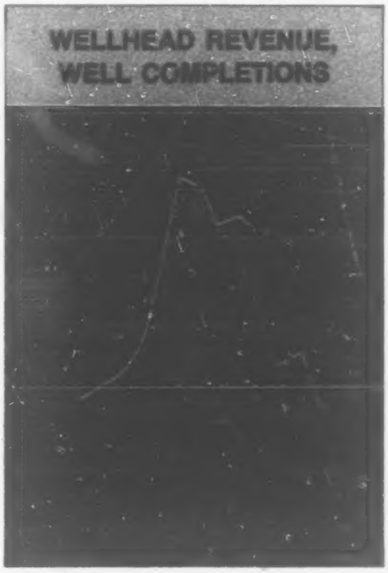
be diverted to handle the debt. The result was a sharper drop in activity than would have been otherwise warranted by the basic economics. Actually the economics of drilling improved during the 1982-1985 period. Drilling costs fell faster than crude prices during this period. But many companies were unable to take advantage of this because of the debt burden they had accumulated during the boom.

The rig count fell to a record monthly and weekly low in July 1986 and then rebounded slightly toward the end of that year. But the recovery was rather weak and rig activity has been depressed ever since 1986. Although crude prices also rebounded at the end of 1986 and remained at a higher level in 1987, the industry was very wary of future prospects. The price crash in 1986 left them quite skeptical. Drilling activity was very sluggish during the first half of 1987. Activity picked up during the second half. But the increase was not sufficient to boost the average for the year and it finished below 1986. The rig count ended the year with 1,162 active rigs, but an annual average of only 936; now the lowest annual average since 1942.

The industry was optimistic that 1988 would show an improvement in rig activity. The year started out well, but OPEC production decisions weakened the price. Rig activity remained sluggish throughout the year. The average rig count for the year was the same as 1987 at 936.

Crude prices moved up again in 1989, but the skepticism had returned. Prices had collapsed in 1986 and 1988 and companies remained extremely reluctant to invest in new exploration and drilling activity. The rig count managed to finally move over 1,000 toward the end of the year. But the average for the year set another modern day low at an estimated 850 for all of 1989.

SEISMIC ACTIVITY. The level of seismic crew activity is one of the better leading indicators of future drilling activity in the U.S. Movements in the level of seismic crew activity tend to lead drilling activity. However, like drilling, seismic activity is also very closely related to the price of crude oil and/or natural gas. Therefore, seismic activity also went through a very volatile period the past few years.


WELLHEAD REVENUE, WELL COMPLETIONS

The seismic crew count moved up rapidly during the drilling boom period. The number of active crews started its climb in April 1976 at 238 crews. And it hit a peak of 744 crews in September 1981, three months prior to the peak in drilling activity. This was one of the warning signals of the coming downturn in drilling activity.

After hitting the peak, the number of active seismic crews fell steadily to 447 in March 1983. This was one month before the rig count hit a temporary bottom at 1,846 average active rigs in April that year.

The number of active seismic crews moved up to 498 by October 1983, an increase of 11.4%. The rig count moved up 38% from April to November 1983. The seismic crew count fell slightly in early 1984, rose in mid-year and then fell at year-end. The seismic crew count fell sharply during the first half of 1985, leading the downturn in rig activity. It moved up marginally in the middle of 1985, but then started down again in August 1985, again leading the decline in drilling activity.

The seismic crew count fell sharply in 1986 and this continued into 1987. It hit a low of 150 in March 1987. This was down 79.8% from the peak in September 1981. The count moved up through the remainder of the year and reached 199 in December of 1987. It slipped a bit during the first half of 1988 and then fell abruptly when prices dropped late in the year The seismic crew count in December 1988 was down to 141, the lowest level in years. This was not a good sign for drilling activity in 1989. The seismic crew count continued to slide in 1989 and fell as low as 124 in June. It started to move up toward the end of the year, but the increase was gradual.

WELL COMPLETIONS. The increase in drilling activity over the 1971-1981 period resulted in a substantial surge in U.S. well completions. Total well completions increased from 26,268 in 1971 to 89,816 in 1981, an increase of 241.9%. This was a record high number of U.S. well completions and far surpassed any previous year. There were 69,713 wells in 1980, the previous high. Prior to those two years the record had been 57,182 wells back in 1956.

Moving along with the number of well completions, the total footage drilled moved up from 127.3 million feet in 1971 to 406.5 million feet in 1981, an increase of 219.5%.

Prices slipped, drilling activity dropped, and then well completions fell slowly over the next few years. They fell to 75,738 in 1983, rebounded to 84,983 in 1984 and were still a high 70,806 in 1985.

Over the period 1981–1985, 404,650 wells were completed, averaging 80,930 per year. By far the biggest boom period in the history of the U.S. oil and gas industry. This gigantic number of well completions was one of the major reasons why U.S. crude oil production was able to reverse its long run decline and actually move up between 1981 and 1985. It is also the reason why U.S. reserves of oil and natural gas were sustained over this period.

During the expansion period 1971 to 1981 well completions moved up 241.9%, but rig activity increased 306.7%. The reason for this was a decline in rig efficiency. The drop in efficiency was due to the employment of less experienced less efficient crews on the new rigs. Well completions per active rotary rig fell from 26.9 wells in 1971 to 22.5 wells in 1981.

On the downswing the opposite was true. From the peak in 1981, well completions fell less than the active rotary rig count. Well

U.S. PRODUCING WELLS

	1980	1981	1982	1983	1984	1985	1986	1987	1988*
Well completions:									
Oil wells	32,120	42,520	39,252	37,396	44,472	36,458	18,598	16,176	13,119
Gas wells	17,132	19,742	18,810	14,505	14,962	12,917	8,055	8,114	8,734
Net abandonments:									
Oil wells	15,798	37,763	16,119	14,248	26,955	10,639	36,534	24,685	20,852
Gas wells	5,019	2,907	6,896	3,306	3,061	3,426	9,872	416	3,837
	20,817	**40,670**	**23,015**	**17,554**	**30,016**	**14,065**	**46,406**	**25,101**	**24,689**
Producing wells: (Dec. 31)									
Oil wells	547,717	557,009	580,142	603,290	620,807	646,626	628,690	620,181	612,448
Gas wells	182,004	198,839	210,753	221,952	233,853	243,344	241,527	249,225	254,122
	729,721	**755,848**	**790,895**	**825,242**	**854,660**	**889,970**	**870,217**	**869,406**	**867,510**

*Estimates

Source: API, abandonments calculated by author

TOTAL WELLHEAD REALIZATIONS AND REINVESTMENT

	Total wellhead revenues ($1,000)	Net of WPT* ($1,000)	(JAS) Total drilling expenditure ($1,000)	Investment ratio (%)
1967	12,274,468		2,299,178	18.7
1968	12,963,514		2,409,360	18.6
1969	13,882,295		2,610,671	18.8
1970	14,919,586		2,578,682	17.3
1971	15,778,480		2,371,492	15.0
1972	15,886,972		2,814,166	17.7
1973	17,951,977		3,074,532	17.1
1974	28,153,951		4,366,989	15.5
1975	32,061,121		6,571,214	20.5
1976	35,801,316		7,461,680	20.8
1977	41,615,676		9,956,453	23.9
1978	46,562,738		13,061,090	28.1
1979	63,164,966		16,078,930	25.5
1980	97,765,720	87,840,720	22,800,356	26.0
1981	138,947,637	113,003,637	36,665,457	32.4
1982	135,526,277	118,772,277	39,428,119	33.2
1983	124,592,334	113,924,334	25,104,543	22.0
1984	132,048,177	123,174,177	25,206,219	20.5
1985	122,047,638	118,047,638	23,696,603	20.1
1986	72,242,658	72,242,658	13,552,403	18.8
1987	75,848,725	75,848,725	9,238,749	12.2
1988E	67,185,000	67,185,000	9,700,000	14.4

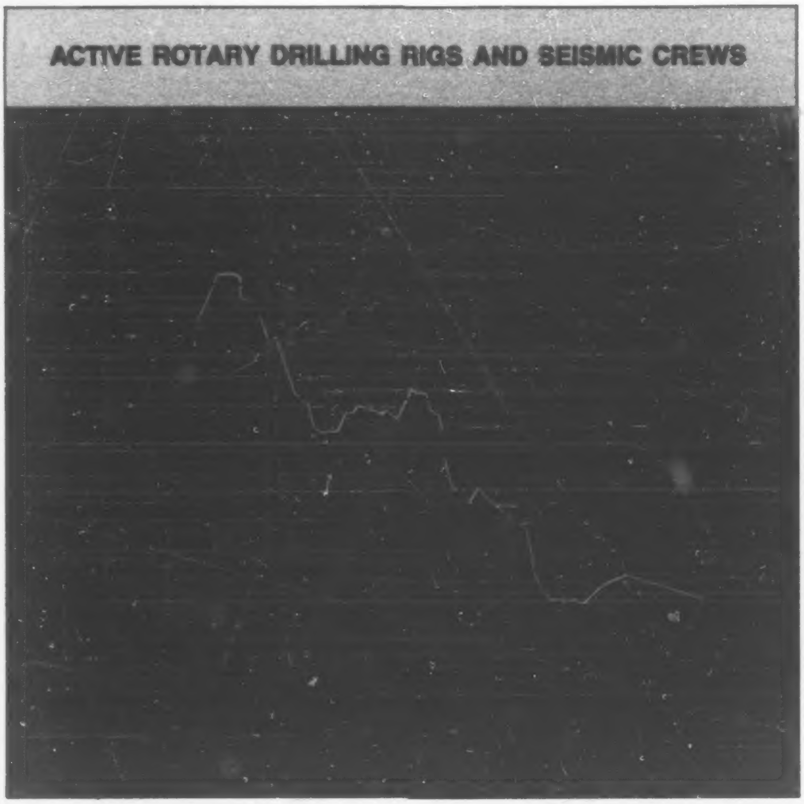
E-Estimate. *Windfall profit tax.

Source: 1970-1987 API, 1988 Author's estimate

DRILLING COSTS*

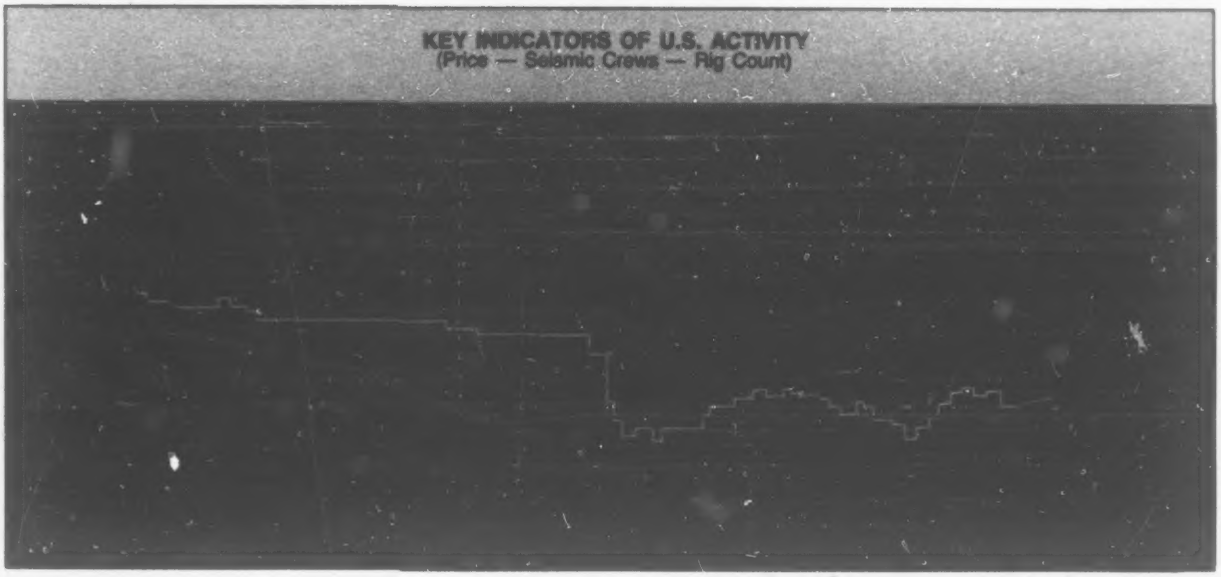
	Total wells†	Total footage† (1,000 ft)	Total expenditures ($1,000)	Avg. cost per well ($)	Avg. cost per foot ($)
1975	36,960	177,642	6,571,214	177,793	36.99
1976	38,941	184,418	7,461,680	191,615	40.46
1977	43,826	212,694	9,956,453	227,181	46.81
1978	46,655	230,619	13,061,090	279,950	56.64
1979	48,523	237,512	16,078,930	331,367	67.71
1980	62,011	296,031	22,800,356	367,682	77.03
1981	80,816	388,800	36,665,456	453,691	94.30
1982	76,652	362,618	39,428,119	514,378	108.73
1983	67,536	301,226	25,104,543	371,721	83.35
1984	77,210	350,589	25,206,219	326,463	71.90
1985	67,821	314,490	23,696,603	349,399	75.35
1986	37,173	176,290	13,552,403	364,577	76.88
1987	33,041	157,357	9,238,749	279,615	58.71

*From the Joint Association Survey. †Doesn't agree with other reported figures because based on survey.



ACTIVE ROTARY DRILLING RIGS AND SEISMIC CREWS

WELLHEAD REVENUE, DRILLING EXPENDITURES



KEY INDICATORS OF U.S. ACTIVITY
(Price — Seismic Crews — Rig Count)

completions and the footage drilled held up quite well when compared to the sharp drop in rotary rig activity.

There were 83,889 well completions in 1982, down 6.6% from 1981. The active rig count fell 21.8% in 1982. By 1985, the rig count had fallen 51%, to 1,980, but well completions were down only 21.7% from the peak. Footage drilled also has not fallen as fast as the rig count. It has remained more closely aligned to the number of well completions. The total footage drilled peaked at 406.5 million feet in 1981. This had fallen to 316 million feet in 1985, down 22.1%.

One of the reasons for the smaller decline in well completions and footage drilled is an improvement in rig efficiency. A reverse of what was happening during the upswing. The number of wells completed per active rig moved up to 35.7 in 1985. At that time rigs were working with more experienced crews. And also adding to rig efficiency was a switch to more development drilling. This is less time consuming then exploration drilling.

During 1986 all of the indicators except rig efficiency collapsed. The active rig count fell another 51.3% to 964 rigs. And the number of well completions fell 44.8% to 39,118 wells. In that year the rig count was down 75.7% from the peak and well completions were down 56.2%. But the number of wells completed per active rotary rig climbed to 40.6.

In 1987, the rig count fell to 936 average rigs, down 2.9%. Well completions totaled 35,732, down 8.7%. And the average wells completed per rig fell to 38.2. This was the first slip in estimated aggregate rig efficiency since the 1981.

The number of active rigs remained at an average of 936 in 1988. But the number of well completions fell to 32,266. Therefore, the number of wells completed per active rig also fell, dropping to 34.5.

Although rig efficiency has improved, the actual improvement in productivity is marginal when measured annually. One of the major reasons for the disparity between rig count and well completions may be the lack of statistical data covering activity of all types of rigs. The Baker Hughes weekly survey of rig activity records active rotary rigs with a drilling depth capability greater than 2,500 feet. Many, if not most, of the more shallow wells are drilled with other types of rigs, which are not counted in this weekly survey. Since more shallow wells are far less costly, the drop in oil prices has not had as big an impact on shallow drilling. Therefore, a larger percentage of the more shallow drilling activity continued during the downturn in the drilling industry. The ratio of total wells drilled to rotary rig activity also includes the wells drilled with other types of rigs. This inflates the number of wells drilled per rig.

The average number of wells completed that are greater than 2,500 feet may be a better indicator of efficiency. Rotary rigs tend to be used for deeper drilling and, therefore, an improvement in the number of these deeper wells drilled per rig is a more accurate efficiency indicator. Wells completed deeper than 2,500 feet per active drilling rig moved up from an average 16.7 during 1971–1981 to 18.2 in 1982. This indicator then increased to 21.7 in 1983, 23.4 in 1984, 24.1 in 1985 and 27.1 in 1986. It dropped to 26.2 in 1987 and 24.2 in 1988. There are a number of factors that influence rig efficiency. But it appears obvious from this rough indicator that rigs are presently employed more efficiently than in the expansion and boom years.

Also of note is the fact that the average depth of wells fell rather sharply from 4,556 feet per well in 1981 to 4,180 feet per well in 1983. Part of the reason for the drop in average depth was a shift away from deep gas well drilling and a concentration on shallow oil well drilling.

The drop in demand for natural gas and the slow-down of the climb in natural gas prices led to the curtailment of a substantial amount of natural gas drilling. Between 1979 and 1983, demand for natural gas fell 17%. This led to the natural gas surplus and resulted in a decline in gas well drilling. This was particularly true for deep gas wells, below 10,000 feet. Close to 1,500 of the rigs that were idled were attributed to the decline in deep well drilling.

The average depth per well has moved up in the last couple of years reaching 4,537 feet per well in 1987 and 2,763 feet per well in 1988. This rise was due to a sharp drop in shallow well drilling, much of which had relatively poor reserve prospects, and an increase in gas well drilling.

WELLHEAD PRICES AND REVENUES. To get a better perspective on what determines the level of exploration and drilling activity, it is essential to take a look at wellhead prices and wellhead revenues.

INDEX OF COST OF DRILLING AND EQUIPPING WELLS

(1984 = 100)	Weight (%)	1983	1984	1985	1986	1987	1988*
Payments to drilling contractors	29.8	114.3	100.0	101.0	85.9	64.4	77.3
Purchased items							
Road site preparation	6.3	96.7	100.0	101.7	103.6	106.2	108.5
Transportation	2.9	100.0	100.0	100.0	100.0	100.0	100.0
Fuel	1.2	101.8	100.0	95.3	58.4	65.4	59.1
Drilling mud and additives	5.8	107.5	100.0	100.6	100.6	100.6	100.6
Well site logging and/or monitoring system	1.6	100.0	100.0	100.0	100.0	87.4	88.9
All other physical tests	0.5	100.0	100.0	100.0	100.0	133.2	138.8
Logs and wireline evaluation services	4.1	95.6	100.0	89.9	67.4	73.0	79.5
Directional drilling services	0.8	101.6	100.0	98.8	98.8	98.8	104.0
Perforate	2.0	100.0	100.0	100.0	100.0	100.0	151.7
Formation treating	4.2	105.9	100.0	94.0	89.3	94.0	95.4
Cement and cementing services	4.3	107.4	100.0	92.7	86.5	90.8	97.3
Casing and tubing	16.8	105.2	100.0	98.8	92.0	98.8	120.0
Casing hardware	0.7	105.2	100.0	98.8	92.0	98.8	120.0
Special tool rentals	3.1	103.3	100.0	100.0	100.0	100.9	102.0
Drill bits and reamers	1.6	99.9	100.0	100.4	98.8	101.2	116.5
Wellhead equipment	2.0	107.2	100.0	103.8	103.9	101.8	105.5
Other equipment and supplies	2.5	100.9	100.0	100.3	99.1	99.8	103.6
Plugging	0.7	98.5	100.0	98.1	97.4	100.4	99.5
Supervision and overhead	3.0	100.3	100.0	103.3	108.1	106.5	109.3
All other expenditures	6.1	97.9	100.0	100.4	96.8	99.3	102.9
Sub-total purchased items	**70.2**	**102.4**	**100.0**	**98.7**	**94.4**	**97.5**	**106.4**
Total†	**100.0**	**105.9**	**100.0**	**99.4**	**91.9**	**87.6**	**97.7**

*Preliminary. †Weighted according to 1982 weights for all years.
Source: IPAA

The close relationship between wellhead prices and rig activity has been documented several times. Between 1971 and 1973, the average wellhead price of oil moved up 123%, and the rig count increased 70.1%. From 1975 to 1981, the average wellhead price increased 320.2%, and the rig count moved up 139.2%.

During this expansion phase of the drilling cycle the average wellhead price of natural gas was also moving up rapidly. The price increased from 22 ct. per thousand cubic feet (mcf) in 1973 to $2.66/mcf in 1984. Between 1973 and 1982, the price increased 1018%. This is an average annual increase of 31%. The natural gas price moved up an additional 5.3% in 1983, and 2.7% in 1984. These later price increases weren't sufficient to stop the slide in drilling activity. But they did provide some additional wellhead revenue to help support additional drilling.

The downturn in drilling activity started after 1981 and followed the fall in prices. Between 1981 and 1985, the average wellhead price of crude oil fell 24.2% and the active rotary rig count fell 50%. And in 1986, the average wellhead price collapsed, falling 48.1%, and the active rig count fell 51.3%.

Adding additional downward pressure on rig activity during this period, the wellhead price of natural gas fell. This dragged the rig count down even more. The wellhead price of natural gas fell 6.6% in 1985 to $2.51/mcf. And then in 1986 it fell another 22.7% to $1.94/mcf. It continued down in 1987, falling to $1.67/mcf. The price in 1987 was down 37.2% from the peak in 1984.

The prices of crude oil and natural gas, coupled with the volume of production, determine the level of wellhead realizations or revenues flowing from production activities. This is also the pool of investment funds that supports a great deal of the future drilling activity. It is expected that a portion of this revenue will be reinvested in exploration and drilling. The total revenue from crude oil and natural gas production and the rate at which it is reinvested are key determinants of the level of drilling activity.

With rising oil and gas prices in the 1970's, total wellhead revenues moved up rapidly. Total U.S. wellhead realizations were $15,778 million in 1971. This moved up and peaked in 1981 at $138,947 million. This was also the year of peak oil prices and a year with a relatively high level of demand for natural gas. At that time the windfall profit tax (WPT) took a portion of the total revenues available. In 1981, net of this excise tax, total wellhead revenues were $113,004 million. Producers were generating 616.2% more revenue per year than they had been ten years earlier. An additional $97.2 billion was flowing to oil and gas producers, investors, royalty owners, and into state and federal excise taxes.

WELL COST AND OIL PRODUCTION

Year	Average cost per well ($)	Wellhead price of oil ($/bbl)	Barrels of oil to cover well cost
1970	94,885	3.18	29,838
1971	94,708	3.39	29,937
1972	106,424	3.39	31,394
1973	117,152	3.89	30,116
1974	138,718	6.74	20,581
1975	177,793	7.56	23,516
1976	191,615	8.19	23,396
1977	227,181	8.57	26,509
1978	279,950	9.00	31,106
1979	331,367	12.64	26,216
1980	367,682	21.59	17,030
1981	453,691	31.77	14,280
1982	514,378	28.52	18,036
1983	371,721	26.19	14,193
1984	326,463	25.88	12,614
1985	349,399	24.09	14,504
1986	364,577	12.51	29,143
1987	279,615	15.40	18,157
1988E	300,590	12.57	23,913

E-Estimate

Source: Department of Energy and API 1970-1987; Author's estimates 1988

TOTAL U.S. OPERATING OIL WELLS

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Flowing	34,786	34,529	38,060	36,065	32,994	36,104	37,665	35,148	32,870	32,497
Artificial lift	492,069	508,981	518,949	544,077	570,296	584,093	609,070	588,256	587,311	579,951
Total	526,855	543,510	557,009	580,142	603,290	620,197	646,735	623,404	620,181	612,448

Source: American Petroleum Institute

TOTAL U.S. SUPPLY OF TUBULAR GOODS

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
Tubular goods (Thous. tons)											
Mill shipments	2,647	2,458	3,612	4,241	1,759	677	1,406	1,299	483	919	1,130
Less exports	−155	−285	−133	−128	−67	−8	−12	−14	−36	−30	−74
Plus imports	591	457	1,036	2,389	2,180	565	2,214	1,506	617	570	988
U.S. supply	3,083	2,630	4,515	6,502	3,872	1,234	3,608	2,791	1,064	1,459	2,044
Footage drilled (Thous. ft.)	238,386	243,685	311,445	406,520	375,706	317,996	369,075	316,169	176,370	162,539	153,695
Tons tubular goods Per thous. ft.	12.9	10.8	14.5	16.0	10.3	3.9	9.8	8.8	6.0	9.0	13.3

Source: IPAA

In addition to the high level of revenue available, the reinvestment ratio in 1981, at 32.4%, was the highest since 1970. The reinvestment ratio is the percentage of total revenues available, that are invested in drilling. Total drilling expenditures in 1981 were $36,665 million.

Total wellhead revenues available to the industry and the reinvestment ratio moved up even higher in 1982. Crude oil prices had started to slide in 1982, but they were still high. In addition crude oil production moved up, and natural gas prices were up. Total gross wellhead revenues slipped to $135,526 million, but net revenue of the windfall profit tax moved up to $118,772 million. And the reinvestment ratio moved up to 33.2%. Total drilling expenditures moved up to a peak of $39,428 million.

As oil prices declined and natural gas demand fell, total wellhead realizations net of the WPT fell to $113,924 million in 1983. Some outside funds stopped flowing into the industry. And the high debt that the industry had accumulated during the peak years had to be financed. This reduced the reinvestment ratio sharply to 22% in 1983. Drilling expenditures fell to $25,105 million.

Total wellhead revenues moved up in 1984 to $123,174 million, net of WPT. Increased natural gas demand was the major reason for the increase. This was partially offset by lower crude oil prices. However, the reinvestment ratio fell to 20.5%. Total drilling outlays were an estimated $25,206 million in 1984. It should be noted that a portion of the drop in drilling expenditures in 1983 and 1984 was due to lower drilling costs. Therefore, the drilling activity level did not drop as much as outlays.

In 1985 the wellhead revenues available to the industry fell to $118,048 million and the reinvestment ratio slid again to 20.1%. Drilling outlays moved down to $23,697 million.

The sharp drop in wellhead revenues and drilling expenditures came with the collapse of prices in 1986. Wellhead revenues fell to $72,243 million, just above the level in 1979. And the reinvestment ratio plummeted to 18.8%. Drilling expenditures fell to the lowest level since 1978, at an estimated $13,552 million.

Wellhead revenues increased in 1987 due to a partial rebound in crude prices. Revenues moved up to $75,849 million. But a pessimistic outlook still prevailed with respect to drilling. The reinvestment ratio fell to 12.2% and drilling outlays dipped to $9,239 million. The reinvestment ratio was one of the lowest on record and drilling expenditures were the lowest since 1977.

Wellhead revenues continued to fall in 1988 due to the drop in crude oil prices. They dipped to $67,185 million, about on par with the $63,165 million in 1979. The reinvestment ratio moved up a bit to an estimated 14.4% and drilling expenditures to $9,700 million.

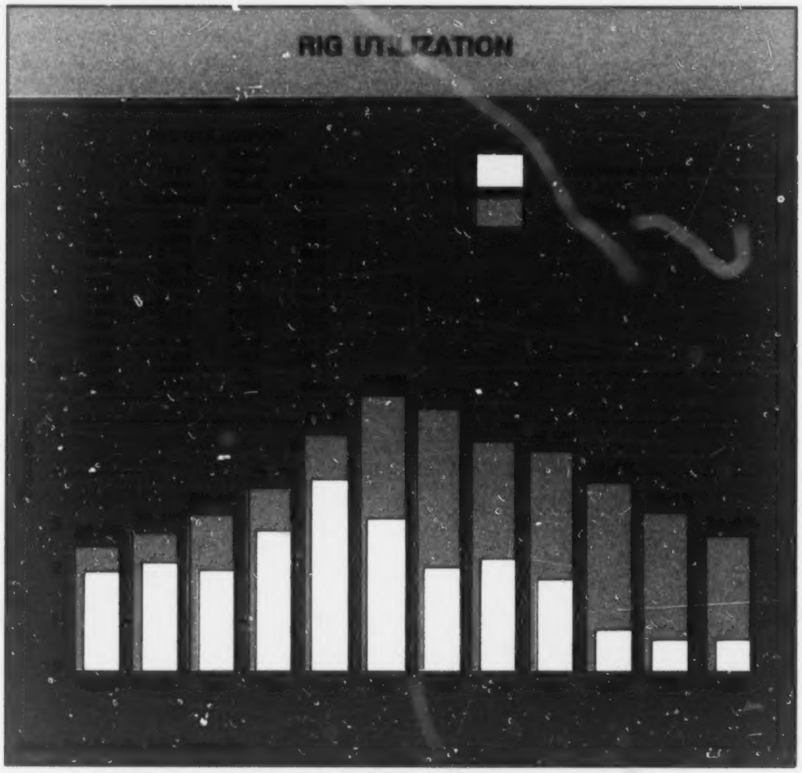
DRILLING COSTS. Increased drilling activity boosted expenditures substantially during the boom years. However, a large part of what was being spent on drilling activity during the boom years was a result of inflation in the cost of drilling a well. According to the Joint Association Survey of Drilling Costs, the average cost of drilling a well increased from $117,152 in 1973 to $514,378 in 1982. This was the record high for the average well cost.

The cost of drilling has fallen sharply since the peak of the drilling boom in 1981-1982. In 1983, the average cost per well fell sharply to $371,721, a drop of 27.7%. The cost continued to slide in 1984, with the average well cost falling to $326,463, down 36.5% from the peak.

The sharp drop in well costs was primarily due to competition in the drilling service and supply industry, brought on by the excess capacity and excess inventory that accompanied the drilling decline. Drilling contractors, as well as equipment and service companies, came away from the boom period with huge excess inventories and production capacities. Prices were slashed in an effort to reduce inventories and use idle capacity.

The average cost of a well moved up slightly to $349,399 in 1985 and $364,577 in 1986. But these increases did not reflect a true increase in drilling costs. A greater proportion of high cost offshore wells were drilled and this increased the average cost estimates.

The average well cost fell to $279,615 in 1987. This sharp drop was due to a 21% decrease in offshore wells drilled.



RIG EFFICIENCY, WELLS DEEPER THAN 2,500 FT

Year	Rig count	Wells	Footage (Million)	Wells/ rig	Footage/ rig	Ft/well (Avg. depth)
1970	1,028	20,146	127.8	19.6	124,364	6,346
1971	976	18,226	116.4	18.7	119,260	6,386
1972	1,107	19,990	127.6	18.1	115,270	6,383
1973	1,194	20,464	129.1	17.1	108,120	6,309
1974	1,471	22,736	139.3	15.5	94,700	6,127
1975	1,660	27,140	164.4	16.3	99,040	6,057
1976	1,656	28,003	168.7	16.9	101,750	6,024
1977	2,001	32,803	196.8	16.4	98,350	5,999
1978	2,255	36,149	218.5	16.0	96,720	6,044
1979	2,176	36,096	221.1	16.5	101,560	6,125
1980	2,910	46,903	279.7	16.1	96,120	5,963
1981	3,970	62,009	368.8	15.6	92,800	5,948
1982	3,105	56,490	338.6	18.2	109,043	5,994
1983	2,232	48,357	280.7	21.7	125,775	5,805
1984	2,428	56,808	330.6	23.4	136,160	5,820
1985	1,980	47,881	285.9	24.2	144,394	5,971
1986	964	26,393	160.9	27.4	166,909	6,096
1987	936	24,491	146.9	26.2	156,944	5,998
1988	936	22,686	140.7	24.2	150,321	6,202

As stated, one of the reasons for the sharp drop in drilling costs was the intense competition in the industry due to the excess capacity. An indicator of excess capacity is the rig utilization rate. The size of the rig fleet moved up with oil prices, increasing from 1,767 rigs in 1973 to 5,644 rigs in 1982. Based on the annual average number of rotary rigs running, the rig utilization rate moved up from 52.5% in 1971 to 81.9% in 1975. The rate stayed in the 68% to 80% range from 1976-1980 as the fleet size grew along with the number of active rigs.

The utilization rate hit 82.7% in

RECORD HIGH AND LOW
Rotary rigs running — by States

State	Rig count 12-28-81	Rig count 7-14-86	Change 86-81	% change 86/81
Alabama-Land	20	3	– 17	– 85.0
Alabama-Offshore	3	2	– 1	– 33.3
Total Alabama	23	5	– 18	– 78.3
Alaska-Land	27	11	– 16	– 59.3
Alaska-Offshore	0	1	1	—
Total Alaska	27	12	– 15	– 55.6
Arkansas	42	7	– 35	– 83.3
California-Land	151	35	– 116	– 76.8
California-Offshore	25	2	– 23	– 92.0
Total California	176	37	– 139	– 79.0
Colorado	93	10	– 83	– 89.2
Florida-Land	4	1	– 3	– 75.0
Florida-Offshore	1	0	– 1	– 100.0
Total Florida	5	1	– 4	– 80.0
Georgia	0	1	1	—
Hawaii	1	0	– 1	– 100.0
Idaho	3	1	– 2	– 66.7
Illinois	105	5	– 100	– 95.2
Indiana	8	1	– 7	– 87.5
Kansas	214	33	– 181	– 84.6
Kentucky	15	3	– 12	– 80.0
N. Louisiana	54	8	– 46	– 85.2
S. Louisiana-In! Water	87	13	– 74	– 85.1
S. Louisiana-Land	175	38	– 137	– 78.3
S. Louisiana-Offshore	168	44	– 124	– 73.8
Total Louisiana	484	103	– 381	– 78.7
Michigan	40	16	– 24	– 60.0
Mississippi	79	13	– 66	– 83.5
Montana	73	2	– 71	– 97.3
Nebraska	18	2	– 16	– 88.9
Nevada	2	2	0	—
New Mexico	160	11	– 149	– 93.1
New York	21	2	– 19	– 90.5
N. Dakota	123	10	– 113	– 91.9
Ohio	94	15	– 79	– 84.0
Oklahoma	871	99	– 772	– 88.6
Pennsylvania	38	15	– 23	– 60.5
Rhode Island—Offshore	3	0	– 3	– 100.0
S. Dakota	1	0	– 1	– 100.0
Tennessee	1	0	– 1	– 100.0
Texas-Offshore	78	15	– 63	– 80.8
Texas-Inl Water	0	1	1	—
District 1	38	4	– 34	– 89.5
District 2	122	11	– 111	– 91.0
District 3	220	22	– 198	– 90.0
District 4	133	26	– 107	– 80.5
District 5	32	9	– 23	– 71.9
District 6	144	18	– 126	– 87.5
District 7B	88	14	– 74	– 84.1
District 7C	99	9	– 90	– 90.9
District 8	206	30	– 176	– 85.4
District 8A	97	25	– 72	– 74.2
District 9	103	16	– 87	– 84.5
District 10	91	11	– 80	– 87.9
Total Texas	1,451	211	– 1,240	– 85.5
Utah	60	6	– 54	– 90.0
Virginia	3	6	3	100.0
Washington	3	0	– 3	– 100.0
W. Virginia	65	13	– 52	– 80.0
Wyoming	228	21	– 207	– 90.8
Total United States	**4,530**	**663**	**– 3,867**	**– 85.4**
Canada	262	68	– 194	– 74.0
Canada-Offshore	5	6	1	20.0
Grand Total	**4,797**	**737**	**– 4,060**	**– 84.6**

Source: Baker Hughes Inc.

1981 as rig activity moved up faster than rig construction. The rig fleet was still growing in 1982 as rig activity fell, and the utilization rate plummeted to 55%. The rig fleet was reduced to 5,273 in 1983, but activity fell faster, and the utilization rate dropped to 42.3%. The total rig fleet was cut again to 4,580 in 1984, and the utilization rate moved up to 53%. In 1985, the rig fleet still stood at 4,409, but the number of active rigs fell to 1,980, resulting in a utilization rate of 44.9%.

But the worst wasn't over and competition really intensified in 1986. The rig fleet fell to 3,993, but the rig count plummeted to only 964. This resulted in a utilization rate of only 24.1%. In 1987, the fleet fell to 3,331 available rigs. The active rig count was 936 and the utilization rate moved up slightly to 28.1%. The rig fleet was further reduced to 2,752 in 1988. With 936 active rigs the utilization rate moved up to 34%. It is these extremely low utilization rates that have put downward pressure on drilling costs.

One of the ironies of this depression period in the domestic oil industry is that with declining drilling costs offsetting the drop in oil prices, the economics of drilling activity improved slightly between 1982 and 1985. The cost of drilling and equipping a well in 1985 was down 32.1% from the peak. In comparison, the average wellhead price of crude in 1985 was $24.09/bbl, down 24.2% from the peak. The profit margin had improved, relative to the profit margin at the height of the drilling boom.

However, that improvement was lost in 1986 when the wellhead price fell to $12.51/bbl. The 1986 price was down 60.6% from the peak, while estimated well costs were down only 30% from the peak. There was a slight improvement in 1987 when the average price moved up to $15.41/bbl. But this was lost again in 1988 when prices fell back to an average $12.57/bbl.

Another way of illustrating the economics is by comparing the volume of oil required to cover the average cost of a well. Between 1970 and 1979, the number of barrels of oil that needed to be produced, to cover the average cost of a well, ranged from a low of 20,581 to a high of 31,394. This fell to 14,193 barrels in 1983, and only

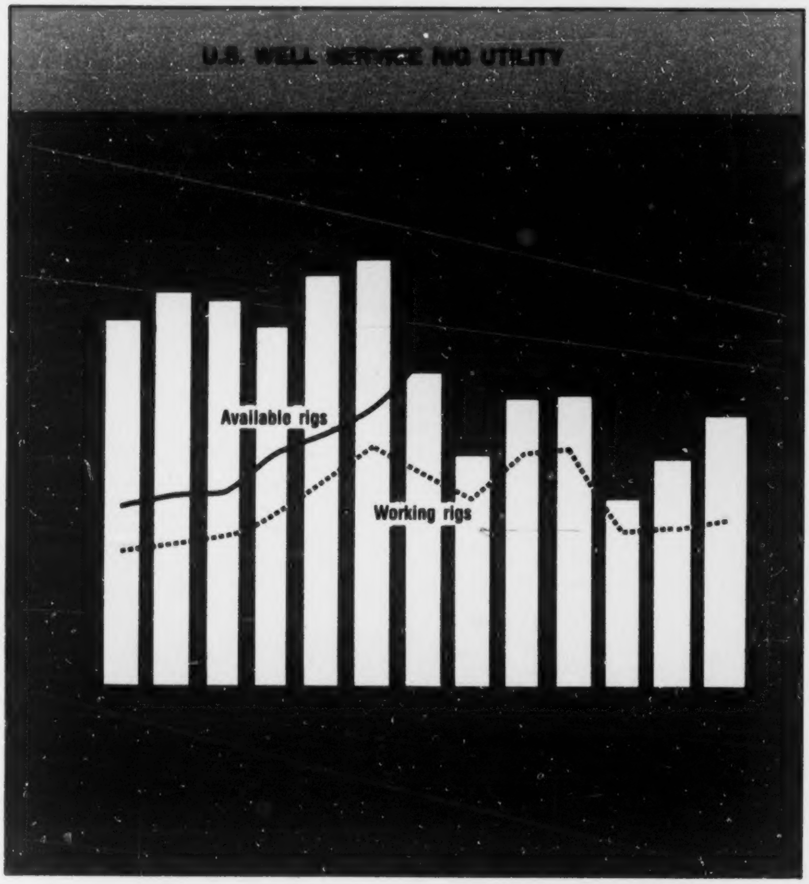
12,614 barrels in 1984. When well costs moved up in 1985, this went up to 14,504 barrels. When prices collapsed in 1986 the volume of oil required to cover well costs jumped to 29,143 barrels. With an increase in crude oil prices in 1987 it improved, falling to only 18,157 barrels. But with crude oil prices down again in 1988, it jumped to 23,913 barrels. This volatility makes drilling decisions very difficult.

PRODUCING WELLS. With the surge in well completions, the total number of producing wells in the U.S. moved up sharply. It reached an estimated 889,970 by year end 1985. In addition to new well completions the higher oil and gas prices helped lengthen the life of old wells and slowed abandonments.

But when prices plummeted in 1986, the number of abandonments increased sharply. In 1986 the number of abandoned wells exceeded the number of well completions. The total number of producing wells fell to 870,217.

The number of producing oil wells dropped from 646,626 in 1985 to 628,690 at the end of 1986. The number of producing gas wells fell from 243,344 wells to 241,527.

Oil well abandonments exceeded completions again in 1987. Therefore, the number of producing oil wells fell to 620,181. There was a slight increase in the number of producing gas wells to 249,225. The total number of producing oil and gas wells slipped to 869,401. It is estimated that this trend continued in 1988. The total number of producing oil wells dropped to an estimated 612,448, while the number of producing gas wells moved up to 254,122. Total producing wells fell to 867,510.



O U T L O O K

The volatility in crude oil prices has introduced a great deal of uncertainty into the upstream sector of the oil and gas industry. And this uncertainty makes it very difficult to predict what will happen to domestic U.S. exploration and drilling over the next couple of years.

The OPEC decisions on production level have been determining the price level in recent years. And it is difficult to predict what the OPEC countries will do concerning production quotas and output.

During the last few years U.S. drilling activity has been at historically low levels. But it looks like this may be the bottom of the cycle. And the most probable outlook is for increased activity over the forecast period, 1989–1994.

The main objective of most of the OPEC countries is to maximize revenue. And therefore it is doubtful that the OPEC countries want prices much below $15/bbl. They have been shown on several occasions that revenues will improve with a little production discipline and higher prices.

Therefore, U.S. domestic crude and natural gas prices are projected to move up modestly over the forecast period. The average wellhead price of U.S. crude will increase slowly to $20/bbl in 1994,

ROTARY RIG ACTIVITY BY STATES

	Average rig activity										
	1988	1987	1986	1985	1984	1983	1982	1981	1980	1979	1978
Alabama	12.0	10.6	10.3	22.3	15.5	15.2	15.3	17.3	10.8	12.6	12.5
Alaska	12.1	8.5	12.8	20.0	14.1	13.8	21.6	23.5	13.8	13.5	15.5
Arizona	0.0	0.2	0.0	0.2	0.2	0.3	1.0	1.1	1.0	0.0	0.4
Arkansas	8.4	9.1	9.6	24.0	26.1	25.9	27.0	33.9	26.8	10.4	13.9
California	60.0	60.9	49.1	80.0	107.2	105.7	128.8	154.8	120.2	95.6	94.1
Land	52.9	54.6	43.8	68.3	89.2	83.4	106.2	133.7	104.7	85.7	86.3
Offshore	7.1	6.3	5.3	11.7	18.0	22.3	22.6	21.1	15.5	9.9	7.8
Colorado	26.7	24.8	24.3	49.8	53.9	52.2	60.3	81.6	61.1	40.2	41.1
Florida	1.4	2.8	2.2	6.7	3.6	4.4	4.6	7.8	4.1	5.3	6.3
Idaho	1.0	0.4	1.0	1.3	0.8	1.2	1.5	3.2	2.6	1.8	3.2
Illinois	3.9	3.4	5.6	28.4	41.5	60.2	75.5	42.9	25.4	13.1	28.4
Indiana	0.0	0.5	1.2	3.6	6.6	5.9	7.1	1.2	0.1	0.3	4.4
Kansas	40.0	48.5	46.8	91.4	127.6	124.1	157.4	196.2	120.2	66.0	75.5
Kentucky	5.1	2.0	2.5	6.3	8.1	8.4	9.5	5.3	1.7	0.4	3.3
Louisiana	163.2	134.7	142.1	282.2	309.9	283.6	343.1	455.6	427.4	347.0	338.3
North	13.9	11.4	11.3	24.5	30.3	29.4	39.9	58.0	54.9	34.5	39.8
Inland waters	25.0	22.9	20.2	85.4	51.4	47.1	59.2	83.2	76.6	62.1	62.5
South	36.7	35.4	41.8	43.4	96.1	81.9	107.8	160.3	156.4	112.3	113.9
Offshore	87.6	64.9	68.8	129.0	132.3	125.2	136.2	154.1	139.4	138.1	122.1
Maryland	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.2	0.5	0.7
Michigan	19.5	21.8	24.0	33.5	34.1	29.1	31.4	36.5	30.7	25.1	24.0
Mississippi	17.5	13.1	15.3	30.8	32.4	32.8	41.6	71.5	57.6	40.2	44.5
Montana	7.8	8.5	9.7	22.7	36.0	23.9	36.2	81.4	49.2	32.9	30.1
Nebraska	2.9	5.2	3.1	6.4	9.1	9.0	9.4	15.0	14.3	9.2	9.6
Nevada	1.8	1.5	2.9	4.9	5.0	1.1	3.0	4.9	4.6	4.1	2.9
New Mexico	36.9	34.6	29.0	71.1	77.8	65.0	103.3	134.9	117.6	87.5	75.5
New York	1.1	2.0	2.2	4.8	8.9	10.2	15.1	11.6	7.0	8.7	7.0
North Dakota	14.5	14.1	13.3	38.3	50.9	42.5	69.4	118.8	83.4	56.5	39.1
Ohio	13.8	19.6	17.5	28.8	51.1	39.3	56.8	97.8	73.7	46.3	45.6
Oklahoma	125.3	136.1	141.2	251.3	319.2	285.5	621.5	696.4	397.3	246.7	258.2
Pennsylvania	16.7	17.4	17.9	29.5	35.5	22.0	32.6	38.6	29.0	28.9	25.2
Rhode Island offshore	0.0	0.0	0.0	0.0	0.0	0.0	2.4	2.0	2.1	4.0	4.3
South Dakota	0.7	0.4	0.6	1.7	2.2	1.0	1.5	2.2	1.9	1.4	2.3
Texas	280.3	293.0	310.9	676.6	850.1	797.5	989.6	1,317.0	987.7	770.2	855.0
Gulf Coast	36.8	42.4	44.5	101.3	138.1	133.9	169.0	305.2	210.5	141.3	197.0
Offshore & inland waters	25.4	19.8	21.7	51.5	60.1	56.2	88.3	74.5	72.1	50.3	46.9
North	28.5	23.8	36.5	86.9	99.6	125.0	138.1	170.7	147.2	122.4	153.2
Panhandle	15.1	16.8	16.0	37.2	49.9	48.3	66.2	66.6	50.8	48.1	60.4
East	37.6	36.2	45.4	77.2	102.1	102.2	115.7	163.9	119.8	107.0	116.6
West Central	43.9	44.8	41.7	81.8	124.5	102.7	139.8	191.6	140.4	109.4	117.2
West	93.0	109.3	105.1	240.7	276.9	229.2	272.5	344.5	247.1	191.7	163.7
Utah	6.1	7.4	11.1	28.5	45.3	36.8	39.8	69.2	42.4	28.9	32.1
W. Virginia	12.6	12.6	15.0	26.1	37.7	33.9	49.4	44.8	37.8	29.8	27.1
Wyoming	36.8	39.3	35.4	92.1	114.6	95.6	142.7	191.3	155.5	147.2	136.4
Others	4.4	3.1	6.9	4.9	3.2	5.0	6.5	8.6	3.3	2.9	2.0
Total U.S.	**936.3**	**935.9**	**963.5**	**1,968.5**	**2,428.2**	**2,232.3**	**3,104.9**	**3,969.5**	**2,910.3**	**2,177.2**	**2,258.8**
Canada land	194.4	179.3	174.8	302.1	242.8	189.5	195.0	258.6	396.4	334.6	270.2
Canada offshore	2.5	2.0	4.1	9.1	13.5	10.4	5.4	4.8	4.7	4.1	1.5
Grand total	**1,133.2**	**1,117.1**	**1,142.5**	**2,279.7**	**2,684.6**	**2,432.2**	**3,305.3**	**4,232.9**	**3,311.4**	**2,515.9**	**2,538.5**

Source: Baker Hughes Inc. Note: Columns may not add due to independent rounding.

an increase of 34.2%. The average wellhead price of natural gas will move up 35.3% to $2.30/mcf.

The result of these increases in prices will be increasing domestic wellhead revenues over the forecast period. The increase from prices will be partially offset by declining crude production and sluggish natural gas production. But prices will be moving up faster than the decline in crude production. And natural gas production will be on the rise over the forecast period.

Total wellhead revenues in 1989 are estimated at $72,205 million. This is up 7.5% from 1988. But drilling outlays are estimated to be down 2.5% at $9.460 million. And the reinvestment ratio is down again to 20.1%. The number of active rigs will record another new low at only 850 average for 1989. The number of well completions will be down to 29,975, a drop of 7.1%.

There are more positive signs that a modest recovery may be underway than negative signs. It would appear that activity in the U.S. exploration and drilling sector bottomed out in 1986–1989, and will be on the rise over the forecast period.

However, 1990 is expected to be another sluggish year. Prices are expected to be weak and at about the same level as 1989. Excess OPEC production will couple with increased non-OPEC production to put excess crude oil on the market. This will keep prices from rising in 1990.

U.S. crude production is expected to fall again in 1990 and natural gas production will only increase marginally. Therefore, total wellhead revenues are expected to slip to $70,840 million in 1990, down 1.9%. However, the reinvestment ratio is expected to move up as the outlook improves for prices beyond 1990. It will increase to around 15.6%. With some stability in crude prices the financially sound companies will boost drilling outlays. Total drilling expenditures will increase to $11,055 million. All of this will not represent new activity since drilling costs are also expected to move up. The average cost per well drilled is projected to move up 4.6% to $330,000. The number of active rotary rigs will move up 11.8% to 950 and well completions will move up to 33,500. A greater proportion of the wells will be gas wells. Total footage drilled will increase to 159,960,000 feet in 1990.

As the prices of crude oil and natural gas increase throughout the remainder of the forecast period, the activity level will continue to rise. The increases will be modest by boom period standards, but there will be a measurable improvement from 1986–1989 levels.

Over the forecast period there will be an increase in cash flow into the upstream sector due to improved wellhead revenues. And some renewed optimism concerning the future of the oil exploration business is expected to result in an increase in the reinvestment ratio. Annual wellhead revenues are projected to increase to $93,505 million in 1994, up $21,300 million. In addition, increased profitability, resolution of debt problems left over from the boom, and an increase in outside investment money, will boost the reinvestment ratio to 20.8% by 1994.

The combination of higher wellhead revenues and an increased reinvestment ratio will result in substantially higher drilling expenditures. Total annual drilling outlays are expected to move up 105.5%, to $19,440 million in 1994.

The average number of active rotary rigs is not expected to increase as rapidly. It is projected to move up to 1,350 in 1994, an increase of 58.8%. Well completions are projected to increase 62.1% to 48,600 wells in 1994. And footage drilled is expected to increase 66.5% to 238 million feet.

These indicators will not increase as rapidly as total spending because there will be an increase in average well costs and a shift to deeper well drilling. Average well costs are expected to increase 26.7% by 1994 to $400,000/well. This will be somewhat less than the projected increase in crude prices. The excess capacity in the service and supply industry is expected to hold down large price increases, particularly early in the forecast period. If well costs move up faster, it could have a negative impact on drilling activity.

The number of deeper wells is expected to increase over the forecast period with renewed exploration activity and increased natural gas drilling. There will be a steady search for more economically attractive reservoirs and a smaller proportion of shallow development drilling. The result will be a steady increase in the average well depth. Well depth is expected to increase 2.7% to 4,900 feet by 1994.

This increase in well depth combined with the increased number of wells will push annual footage drilled up substantially. Annual footage drilled will be up 95.1 million feet by 1994.

The rough measures of drilling rotary rig efficiency are expected to show little change over the forecast period. There will be a shift to deeper wells and more exploratory work. And these wells take longer to complete. These changes are expected to be offset by gains in operational efficiency. The number of wells drilled per active rotary rig will average 35.3 in 1989. This will increase to 36 wells per rig in 1991 and stay at that level throughout the rest of the forecast period. Footage drilled per rig is projected to move up in 1989 to 168,235 feet. Footage per rig is expected to move up slowly throughout the forecast period increasing to 176,400 feet in 1994. This would be a modest increase of 4.9%, 8,165 feet per rig.

The economics of oil well drilling are expected to improve over the forecast period. Prices are expected to move up faster than well costs. The number of barrels of oil needed to cover the average cost of a well is estimated at 21,183 in 1989. It is expected to gradually improve falling to 20,000 barrels in 1994.

The number of well abandonments are expected to decline slowly throughout the forecast period. With increased prices producers will be able to maintain marginal wells for a longer period. The total number of producing wells will steadily increase as well completions outnumber abandonments. There is expected to be an increase in total gas wells. Total producing wells will reach 922,580 in 1994.

THE OUTLOOK—EXPLORATION, DRILLING, PRODUCTION

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
DRILLING ACTIVITY									
Active drilling rigs	936	850	950	1,050	1,150	1,250	1,350	+500	+58.8
Weil completions	32,270	29,975	33,500	37,800	41,400	45,000	48,600	+18,625	+62.1
Footage drilled (thousands)	153,712	143,000	159,960	180,680	198,720	218,250	238,140	+95,140	+66.5
Av. well depth	4,763	4,770	4,775	4,780	4,800	4,850	4,900	+130	+ 2.7
Welis drilled per active rig	34.5	35.3	35.3	36.0	36.0	36.0	36.0	+0.7	+ 2.0
Footage drilled per active rig	164,220	168,235	168,380	172,075	172,800	174,600	176,400	+8,165	+ 4.9
REVENUE AND COST									
Av. well cost ($)	300,590	315,620	330,000	345,000	362,250	380,360	400,000	+84,830	+26.7
Total wellhead revenues ($ million)	67,185	72,205	70,840	74,135	81,665	87,900	93,505	+21,300	+29.5
Total drilling expenditures ($ million)	9,700	9,460	11,055	13,040	15,000	17,115	19,440	+9,980	+105.5
% of wellhead revenue invested in drilling	14.4	13.1	15.6	17.6	18.4	19.5	20.8	+7.7	+58.8
PRODUCTION									
Capital expenditures ($ million)	2,088	2,065	2,410	2,850	3,275	3,735	4,245	+2,180	+105.6
Producing wells (oil & gas) (Dec 31st)	867,510	867,100	870,045	877,125	888,625	903,920	922,580	+55,480	+ 6.4
Abandoned wells	23,190	21,000	20,000	18,850	16,860	15,530	14,750	− 6,250	−29.8
PRICES									
Crude Oil (Av. wellhead-$/barrel)	12.57	14.90	14.75	15.65	17.50	19.00	20.00	+5.10	+34.2
Natural Gas (Av. wellhead-$/mcf)	1.71	1.70	1.70	1.80	2.00	2.15	2.30	+0.60	+35.3

EXPLORATION, DRILLING, PRODUCTION—KEYS TO THE FUTURE

1. Excess worldwide crude production will keep prices low in 1990. Crude oil and natural gas wellhead prices in the U.S. will remain close to present levels in 1990. But prices will move up over the remainder of the forecast period.

2. Wellhead revenues will be down in 1990 due to lower U.S. crude oil production. After 1990 increased prices will couple with increased natural gas production to boost wellhead revenues. That increase will be partially offset by lower crude production.

3. Increased wellhead revenues and higher prices will boost investor confidence throughout the forecast period. The reinvestment ratio will move up, making more money available for drilling.

4. Drilling outlays will move up faster than prices. They will be boosted by increased revenues and the higher rate of reinvestment. The improved picture for prices will encourage more exploration and drilling activity.

5. The increase in drilling outlays will boost the rig count, the number of well completions and the total footage drilled.

6. The economics of drilling will improve marginally as prices increase faster than well costs. Excess capacity in the service and supply industry and increased efficiency will hold down well costs.

REFINING AND PETROCHEMICALS

■

The refining and petrochemical industries both in the U.S. and worldwide have gone through a prolonged period of adjustment. The abrupt movements in crude oil and product prices that plagued exploration and drilling activity also had a substantial impact on the downstream sector of the worldwide oil and gas industry.

The movements in the refining and petrochemical industries did not appear as volatile as in the exploration and production sector. But these downstream sectors have also gone through significant changes over the past few years. It did not appear as volatile, because making significant changes in the level of activity in the refining and petrochemical industries requires a much longer lead time. Any reductions or additions to capacity tend to be quite costly. Therefore, careful analysis is required before making a major change in operations. Adding basic refining distillation capacity requires considerable lead time for planning and construction. To add facilities for additional processing to handle heavier and more sour crudes requires considerable lead time for planning and construction. To add new petrochemical capacity to meet new demand generated by economic growth requires time for planning and construction. All of these projects are major investments and therefore require careful detailed economic analysis.

And the decision to make any of these changes requires a certain degree of certainty concerning future market prospects. Planning for potential future activity is much more difficult in today's rapidly changing markets than it was in the past. When demand was steadily on the rise through the 1950's, 1960's and 1970's, planning consisted of carefully timing new added capacity to meet expected needs.

During that period there was a great deal of certainty about the future trend in demand and the potential capacity required. The level of risk was relatively low and related to the timing of the investment. There was not a great deal of fear of building excess capacity.

This all changed in the late 1970's when demand peaked and turned down. Although the changes that followed in the refining business did not appear as volatile as in the exploration and production sector, they were probably more significant. The refining industry had not been through a similar cycle before—a cycle where overall capacity had to be reduced due to a new perception of demand. What was now significantly different was the fact that for the first time long range expectations were for lower demand.

And now to confuse the issue, expectations have changed again. Product demand again appears to be steadily rising. A great deal of uncertainty and risk has been introduced into the refining and petrochemical industries. And it is expected that the markets will be more volatile for the foreseeable future.

REVIEW

REFINING CAPACITY. Virtually from its inception, the refining industry in the U.S. has been an industry of slow, steady growth. The growth had been slow and steady with few interruptions. The exceptions were only some minor slowdowns due to economic recessions. But this changed dramatically at the end of the 1970's.

Looking at just the last portion of that growth period illustrates vividly what was happening in the industry at the time of the transition.

Demand for petroleum products in the U.S. increased 8.9%, from 17.308 million b/d in 1973 to 18.847 million b/d in 1978. United States refining capacity moved up from 13.7 million b/d in 1973 to 18.6 million b/d in 1981, an increase of 4.9 million b/d or 36.2%. During that period, capacity was expanding to meet increasing actual demand and to meet the certain expected future demand. The number of plants operating increased from 253 in 1973 to 315 in 1981. Total plants moved up from 281 to 324. The number of available plants that were shut down was reduced from 28 in 1973 to just 9 in 1981.

The expansion phase in the refining sector actually continued beyond the peak period for demand. Refining capacity continued to increase through 1981, although demand had peaked in 1978. The refining industry in 1980 and 1981 was still operating under the guidance of old long-term outlooks that foresaw increasing demand. The initial downturn in demand was thought to be only temporary. New facilities to meet the expected future increase in demand were already under construction. Therefore, excess capacity continued to be added well beyond the peak year.

Before the downturn was felt in the upstream segment of the business, it was, however, being detected in the refining sector. Demand for petroleum products had begun to slip. But it was not interpreted immediately as an extended downturn in demand.

But it was a major turning point. Demand for petroleum products in the U.S. fell for five consecutive years in response to the massive price increases of the mid and late 1970's. Demand fell 3.616 million b/d, 19.2%, to 15.231 million b/d in 1983. But as stated before, refining capacity continued to increase through 1981. However, crude runs peaked in 1979 along with demand for petroleum products and the refinery utilization rate began to fall.

With demand falling and refining capacity on the rise, a growing and large excess refining capacity developed in the U.S. and worldwide. The utilization rate in the U.S. which was as high as 90.9% in 1973, and averaged 86.6% from 1973 to 1979, dropped to 75% in 1980. As demand continued to fall, the rate dropped to extremely low and unprofitable levels. The rate of utilization fell below 70%: 67% in 1981, 65.8% in 1982 and 69.3% in 1983. Prior to the downturn, between 1973 and 1979, excess capacity ranged from 1.2 million b/d to 2.8 million b/d. This was mainly contingency capacity to account for maintenance downtime and surges in product demand. After 1979 excess capacity jumped up to 4.5 million b/d in 1980 and to

U.S. REFINERY CAPACITY AND UTILIZATION

	Number of plants*			Total capacity†	Crude runs	Utilization rate	Excess capacity
	Operating	Shut-down	Total	(1,000 b/d)	(1,000 b/d)	(%)	(1,000 b/d)
1973	253	28	281	13,671.4	12,431	90.9	1,240.4
1974	257	27	284	14,361.5	12,133	84.5	2,228.5
1975	262	28	290	14,960.7	12,442	83.2	2,518.7
1976	265	22	287	15,236.6	13,416	88.1	1,820.6
1977	273	18	291	16,398.4	14,605	89.1	1,793.4
1978	290	12	302	17,047.7	14,739	86.5	2,308.7
1979	301	10	311	17,440.9	14,646	84.0	2,794.9
1980	311	8	319	17,988.1	13,482	74.9	4,506.1
1981	315	9	324	18,620.5	12,471	67.0	6,149.5
1982	254	47	301	17,889.7	11,774	65.8	6,115.7
1983	233	25	258	16,859.3	11,685	69.3	5,174.3
1984	214	33	247	16,137.1	12,044	74.6	4,093.1
1985	199	24	223	15,658.8	12,002	76.6	3,656.8
1986	192	24	216	15,458.9	12,716	82.3	2,742.9
1987	195	24	219	15,565.5	12,854	82.6	2,711.5
1988	195	18	213	15,915.4	13,246	83.2	2,669.4

*As of January 1. †As of January 1. Includes operating and operable shutdown.

Source. Energy Information Administration, American Petroleum Institute

REFINERY CASH OPERATING MARGINS

Gulf Coast average (dollars per barrel)

Year	Margins
1975	−0.47
1976	0.26
1977	0.60
1978	0.53
1979	1.47
1980	1.55
1981	0.33
1982	0.27
1983	−0.46
1984	−1.10
1985	−0.02
1986	−0.01
1987	−0.41
1988	1.42

Source: Wright Killen & Co

6.1 million b/d in 1981 and 1982.

With excess refining capacity, refining margins and profits fell sharply. While earnings from exploration, drilling and production activities were still substantial, the refining sector was experiencing a period of low earnings and even losses for some operations.

The drop in demand resulted in a change in the perception of the longer-range trend in product demand. Following this there was a substantial change in the long-range forecasts of petroleum product demand. Expectations of product demand increases paralleling the long-range growth in economic activity, and moving up 3-4%/year, were put to rest. Refiners realized that the lower demand levels they were experiencing were not a temporary economic phenomenon. They realized that they could not simply wait for demand to return to the previous growth trend. The refining industry realized that a capacity adjustment to lower demand levels was required. Capacity would have to be reduced in order to increase the utilization rate, cut unit costs, and improve margins and profits.

From the peak in 1981, annual average total distillation capacity moved down 17%, falling to 15.5 million b/d in 1986. This was a cut in capacity of 3.162 million b/d. The number of plants operating fell from 315 in 1981 to 192 in 1986, a drop of 123, and the number of total plants was down from 324 to 223, off 101. The number of plants temporarily shut down moved up to 24, and many plants were closed permanently.

Refining capacity was reduced, in order to close the gap between capacity and demand. The operating objective was to boost the utilization rate, reduce unit costs, improve margins and increase profitability. The refining industry had historically operated in an atmosphere of ever-expanding refining capacity in response to demand for products. Adjusting their planning process to accommodate a shrinking industry was difficult. But a more lean and efficient industry was essential if refinery margins and profitability were to improve.

Demand for petroleum products turned around again in 1984, after prices had fallen sufficiently to slow the conservation effort. It has grown slowly and steadily since that time. Demand in 1989 is estimated at 17.56 million b/d, up 2.329 million b/d, 15.3%, since 1983. As a result of this upward shift in demand, refining capacity stopped its slide. In fact, refining capacity increased slightly in 1987 and 1988 due to the higher product demand. Average annual refining capacity increased 456,500 b/d.

But some excess capacity still existed. Restructuring and consolidation in the industry resulted in a reduction in capacity in 1989, down 301,000 b/d.

Most projections now call for improved demand in the future. And refining is a competitive business. Capacity is being adjusted as refiners attempt to define their most profitable market, increase market share, or make other adjustments to increase profitability.

The utilization rate, based on crude runs, has moved back up to a more acceptable level, at 82.6% in 1987 and 83.2% in 1988. It is estimated at 86% for 1989. Due to

REFINERY RUNS BY DISTRICTS

					Crude runs					
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
					1,000 b/d					
East Coast	1,478	1,296	1,202	1,103	960	1,019	1,061	1,122	1,153	1,198
Appalachian Dist. 1	167	158	132	93	77	87	92	101	98	100
Total Dist. 1	1,645	1,454	1,334	1,196	1,037	1,106	1,153	1,223	1,251	1,298
Appalachian Dist. 2	65	51	54	51	53	58	60	54	—	—
Ill., Ind., Ky.*	2,353	2,063	1,803	1,714	1,798	1,784	1,777	1,847	1,930	1,944
Minn., Wisc., Dak.	294	238	229	251	253	282	285	294	287	307
Okla., Kan., Mo.	1,017	943	883	763	642	636	617	627	627	665
Total Dist. 2	3,729	3,295	2,969	2,779	2,746	2,760	2,739	2,822	2,844	2,916
Texas:										
Inland	472	445	469	456	474	499	472	472	470	480
Gulf Coast	3,462	3,142	2,829	2,726	2,801	2,780	2,750	2,990	2,909	3,021
Louisiana Gulf	2,167	2,085	2,030	1,941	1,862	2,012	1,972	2,162	2,230	2,261
N. La., Ark.	200	186	163	162	170	177	168	170	164	176
New Mexico	89	86	81	77	75	68	60	63	66	69
Total Dist. 3	6,390	5,944	5,572	5,362	5,382	5,536	5,422	5,857	5,839	6,007
Total Dist. 4	477	442	425	416	420	436	432	431	437	452
Total Dist. 5	2,405	2,347	2,171	2,021	2,100	2,206	2,256	2,383	2,483	2,573
Total U.S.	14,646	13,482	12,471	11,774	11,685	12,044	12,002	12,716	12,854	13,246

*Beginning in 1987 includes Appalachian Dist. 2.

Source: Energy Information Administration

this improvement in the utilization rate, increased demand and improved efficiency, the financial conditions in the refining industry have improved markedly.

In 1985-86 the refining sector received a financial boost when a number of OPEC countries, led by Saudi Arabia, adopted netback pricing. At that time the market was flooded with readily available crude oil and crude costs plummeted.

The combination of lower crude costs and netback pricing boosted refining margins substantially for a short period. Lower crude costs meant lower refinery feedstock costs. Crude costs fell faster than product costs. And for many refiners netback contracts virtually locked in a profit margin for every barrel of crude purchased and processed.

But with the OPEC adoption of new production quotas in late 1986 and 1987, and a tightening of the market, crude prices moved back up. Netback pricing was scrapped by the crude producers. And refining margins disappeared.

However, in 1988 there was another surge in margins and refining profitability. Crude costs slid, lowering feedstock costs. And at the same time, demand continued to move up, increasing the refinery utilization rates, lowering unit production costs and improving operating margins. The increased demand boosted revenues. Product prices remained relatively stable and did not fall along with crude costs, due to the increased product demand. All of this led to a sharp increase in refining profits.

Even with the excess capacity situation, capital expenditures for refining facilities remained relatively high over the 1981-1985 period. A substantial portion of the investment was for upgrading capacity to handle cheaper, but heavier, crude oils. Investment was made to enable production of a greater yield of lighter products also. Expectations are that demand for lighter products will increase in the future much faster than for the heavier fuel oil. Therefore, as overall distillation capacity was falling, upgrading capacity was increasing.

Illustrative of the shift to a greater demand for lighter products is the shift in resid and gasoline demand. In 1977, resid demand represented 16.7% of the demand barrel, and gasoline 38.9%. By 1985, this had shifted to resid only 7.6% and gasoline 43.4%. There was a slight reversal in this trend in 1986 as resid moved up to 8.7% and gasoline dropped to 43.2%. But when prices moved back up in 1987, resid fell to 7.6%. With lower prices resid demand moved up in 1988 and the resid portion rose to 8%. It is estimated that it will remain at 8% in 1989.

There are some signs that there could be a resurgence in resid demand if prices remain at a level low enough for resid to compete in the industrial and utility markets.

Nevertheless, over the past few years the investment has been concentrated more in upgrading and modernization. Capital spending for refining facilities moved up rapidly between 1978 and 1982 increasing from $1,551 million to $5,775 million. Over the next four years, during the downturn, refining outlays fell steadily to an estimated $2,073 million in 1986. The trend reversed in 1987 and investment increased to $2,180 million. It moved up again in 1988 to $2,874 million. Modernization continued and there was some additional capacity added. Capital expenditures in 1989 are estimated at $3,179 million.

REFINING MARGINS. One of the key financial indicators of the efficiency of refining operations is refining margins. Margins measure the difference between the value of the refined barrel, and the combined cost of feedstocks and refining operations.

During the latter part of the expansion period, the total value of the refined barrel went from $14.73 in 1977, prior to the second large price hike, to $39.07 in 1981. The refiners acquisition cost of crude moved up from $11.96 in 1977 to $35.24 in 1981. Between 1977 and 1981, the net value to the refiner after subtracting refining costs was generally positive, averaging about $0.89/bbl.

However, in subsequent years, rapidly rising crude oil costs, coupled with rising refining costs, as the utilization rate fell, turned net margins negative. Falling product sales and high unit costs due to the low capacity utilization rate kept margins generally low or negative.

Increased demand and a higher refinery utilization rate helped refinery margins improve in 1985. And in 1986, low crude costs and an even higher utilization rate boosted margins again. Netback contracts with some major OPEC producers also helped some refiners.

When crude costs moved back up in 1987, operating margins again turned negative. A very competitive product market kept product prices from moving up. And margins were squeezed when feedstock costs increased with the higher crude prices.

The situation was reversed in 1988. Falling crude prices reduced feedstock costs. At the same time, strong product demand enabled refiners to hold the line on product prices. This resulted in substantially improved margins. Margins started out the year negative but then rapidly moved up as crude prices fell. By the end of the second quarter of 1988 margins had reached some of the highest levels in recent years. Refining margins were not as high as at the end of 1988, but remained positive for the first half of 1989. The picture remained rather bright for the refining industry.

PETROCHEMICALS. Companies in the petrochemical industry posted record profits in 1988 and 1989. The continuing increase in economic activity boosted demand for petrochemical products. Increased demand and relatively stable prices boosted revenues substantially. This combined with low or falling feedstock costs to increase margins and boost profits. With increased demand, the capacity utilization rate was up, which cut unit operating costs, adding further to margins.

The chemical/petrochemical industry activity closely follows the growth pattern of the overall economy. The U.S. economy has just gone through an unprecedented period of continuous growth, and demand for petrochemicals has followed. Rising demand has helped eliminate the excess capacity problem that had depressed the industry for several years.

Rapidly rising crude prices in the late 1970's and early 1980's had an impact on the petrochemical industry similar to the impact on refining. Increased crude prices meant increased feedstock costs for the petrochemical industry. This reduced margins and forced the industry to boost prices to recover the higher feedstock costs. The higher product prices tended to reduce demand.

Demand leveled off, and an excess capacity problem developed. Worldwide capacity additions had exceeded demand for several years. Capacity had been built up in the anticipation of ever increasing demand. Besides capacity additions in the industrial countries, additional capacity has been added recently in the Middle East, aggravating this situation. Some of the OPEC countries have been investing in downstream facilities as part of their long range growth plans.

The estimated U.S. capacity utilization rate fell as low as 66% in 1982. In 1982, higher product prices resulting from rising feedstock costs and slower growth in economic activity reduced demand for petrochemicals. This further aggravated the excess capacity situation.

Demand picked up in 1983 and 1984, increasing at an annual rate of about 7-8%. It stagnated in 1985-1986, showing little net growth over that two year span. But general worldwide economic growth in 1987 and 1988 again boosted demand. Growth over those two years is estimated at over 8% per year.

Capacity additions were held in check over this period, and therefore the utilization rate moved up sharply. It was estimated that in 1988, plants worldwide were operating at over 90% of capacity.

U.S. ethylene capacity was cut from the high of around 18.2 million metric tons per year in 1981 to 16,985 million metric tons in June 1988. This put capacity more in line with demand estimated at 16 million metric tons per year.

During the period of excess capacity, the petrochemical industry found itself trapped with sluggish demand and depressed margins. Feedstock costs were high. The utilization rate was low increasing unit production costs. Demand was not increasing, and product prices were held low because of intense competition.

This situation had changed dramatically by 1987-1988. Demand had risen substantially and was continuing up. Prices were firm due to increased demand and less excess capacity. The operating rates were up, reducing costs. And feedstock costs were relatively low due to low crude prices. As a result, petrochemical margins were up substantially, and good profits were being posted.

U.S. Gulf coast average cash margins for E/P mix were 2.72 ct./lb of ethylene produced back in 1985. This had moved up to over 20 ct./lb in 1988. Light naphtha cash margins were only 0.20 ct./lb of ethylene in 1985. This was up to over 25 ct./lb in 1988. Margins have held at these higher levels through 1989.

There is a lot of optimism in the petrochemical industry. But there is also the fear that these huge margins will result in additional capacity being added. And this will result in another period of excess capacity in the 1990's. U.S. ethylene capacity jumped up 15.5% between June 1988 and June 1989, to 19.616 million metric tons/year. Total world capacity also increased up 6.6% to 51.972 million metric tons/year. The increase in the U.S. was the largest but the other areas also posted increases; Latin America +2.5%, Western Europe +0.7%, Asia Pacific +3%, and all others +3.4%. The fears of excess capacity may be coming true. The ability to profitably use this additional capacity will depend upon the rate of growth in economic activity.

OUTLOOK

In general, the outlook for the U.S. refining and petrochemical industries is quite positive. Both industries have resolved their excess capacity problems. They have brought capacity in line with present and expected future demand. Demand is on the rise and profits have been good.

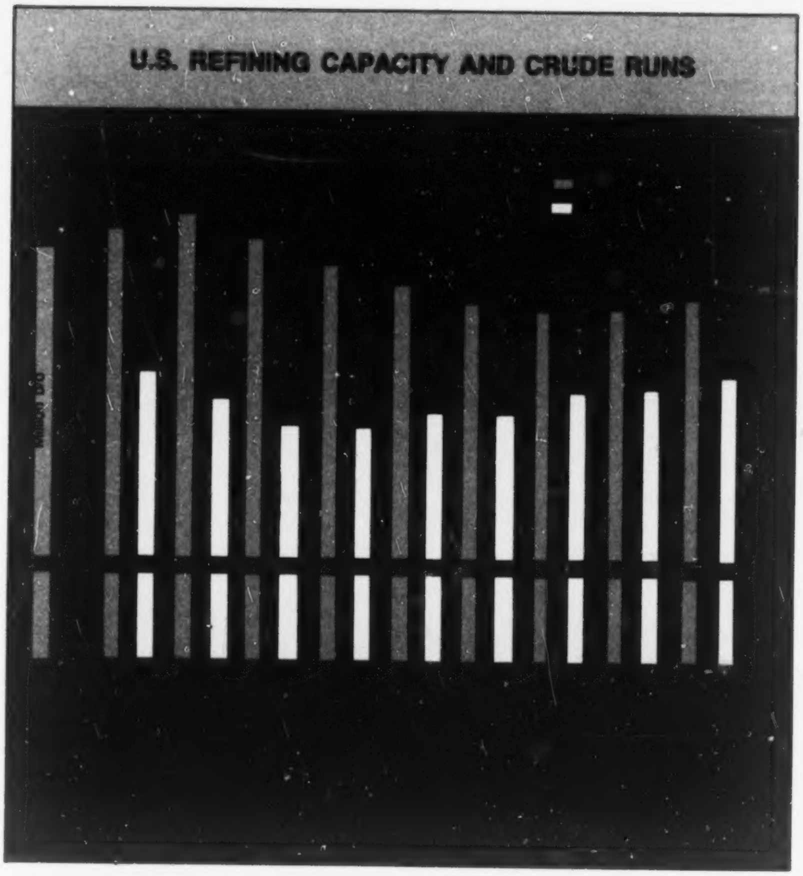
Total U.S. demand for petroleum products has moved up 15.3%, an increase of 2.329 million b/d, from 1983-1989. Over the forecast period, demand is projected to increase an additional 1.35 million b/d, up 7.7%. In 1994, demand is forecast to be a record 18.91 million b/d. This will surpass the peak years of 1977-1979.

Total U.S. refining capacity, which was slimmed down due to the lower demand levels, is projected to be on the increase over the 1989-1994 period. Total U.S. refining distillation capacity is expected to be increased 4.2% to 16.28 million b/d in 1994.

Refiners prefer a utilization rate of 85-90%. This rate is more efficient and profitable. Increased demand will boost the utilization rate to 88-90% for the forecast period. Refinery crude runs and total input to distillation units will also increase. Crude runs will move up 7.6% to 14.47 million b/d and inputs to distillation units will increase to 14.66 million b/d in 1994. Most of the increase in demand will be met by increased domestic product production. As a result, the refinery utilization rate will move up. The utilization rate will increase steadily over the next five years and is projected to increase to 90% in 1994.

Increased demand could also be supplied by product imports. However, refiners prefer to utilize existing refining capacity if possible. However, product imports are expected to move up along with demand over the forecast period, increasing 175,000 b/d, 7.6% by 1994. The level of product imports will depend upon the relative cost of imported products compared to the domestic cost of production.

Refiners at present are operating quite profitably. Increased profitability in the future will depend



upon increased demand and increased refining operating efficiency. Crude oil costs are expected to move up slightly faster than product prices over the forecast period. However, some of the relatively larger increase in crude costs is attributable to the depressed price level at present.

The refiner acquisition cost of crude oil is expected to move up 34.4% to $23.45/bbl in 1994. The pump price of motor gasoline is expected to move up 20.3% to $1.305/gal in 1994. Distillate home heating fuel oil is projected to move up 22% to $1.055/gal in 1994.

Although these price increases will somewhat close the gap between feedstock costs and product values, profitability could remain fairly high. The increased utilization rate will reduce unit operating costs. And increased demand will boost total revenues.

Refiners will not have the luxury of net-back deals to insure improved margins during the forecast period. However, several refiners have worked out or shown interest in joint agreements with producing countries. This type of renewed vertical integration could also help boost profits. It will remove some of the uncertainty and allow for more efficient planning.

Capital spending is expected to remain relatively high in the future to meet changing product demand patterns and to meet changing crude qualities. It will be essential to have the ability to handle the heavier crudes and to be able to upgrade the output and produce a greater yield of lighter products. This will be essential for long-term profitability in the refining industry. Even though resid demand is expected to increase over the long run, lighter products will be the most profitable for refiners.

Capital spending in the refining industry is projected to move up through the forecast period. The increased outlays will be for the added capacity modernization and increased upgrading capacity. Refiners are planning to be able to handle heavier crude in future years. And it is still expected that it will be more profitable to have a higher yield of lighter products.

A recent study showed that it is expected that world crude oil will continue to get heavier and have a greater sulfur content. The API weight of crude processed by U.S. refiners will move from about 32.6 at present to 31.8 in 1985 and 31.1 in 1990. The average sulfur content will go from about 0.96% to 1.07% in 1985 and 1.18% in 1990. New environmental rules will also result in increased investment for new facilities. In fact, environmental concerns may force substantial new investment in the future.

Capital spending in the refining industry is projected to increase 22.7% over the forecast period, moving up to $3.9 billion in 1994.

The future for the petrochemical industry also appears favorable. Demand is expected to grow at an annual rate of 4-5%. The one problem that may arise during the forecast period is the development of excess capacity in the early 1990's. A recent study showed plans to add an additional 27.9% to U.S. ethylene capacity by 1993. The large additions in 1989 support that study. However, some of this increase may be offset by the idling of some older capacity.

If demand does not keep pace with these additions, then excess capacity will reduce operating rates. This would reduce margins and profitability.

Another problem that may arise is increased foreign competition. Demand has increased in Europe and elsewhere in the world. This may result in capacity being added overseas. The additions in 1989 may be just the start in increasing non-U.S. capacity. In addition, there are the new petrochemical export facilities in the Middle East that are producing low cost product intended for export. These facilities have very low feedstock costs and in some cases have government subsidies. Saudi Arabia with huge oil and gas reserves has stated that its goal is to obtain a larger share of the petrochemical market.

The result could be low cost foreign petrochemicals competing in the U.S. market and depressing prices. This has resulted in some petrochemical producers planning to move away from the feedstock-intensive commodities business and shift towards the higher value-added specialty products markets.

Capital spending by the U.S. oil companies on petrochemical facilities is expected to increase 25% over the forecast period to $3.66 billion in 1994.

Despite the potential problems associated with excess capacity and the environment, at the present the expectations are for future growth and increased profit potential.

REFINING AND PETROCHEMICALS—KEYS TO THE FUTURE

1. Demand for petroleum products in the U.S. will increase throughout the forecast period. Demand will be up 7.7% by 1994, an increase of 1.35 million b/d. This will be a record high.

2. U.S. refining capacity will move up along with demand. Capacity will be expanded to 16.28 million b/d by 1994, up 1.025 million b/d, an increase of 7.6%.

3. Increased crude runs to meet demand will boost the refinery utilization rate to a more profitable level. The rate will remain between 88–90% throughout the forecast period.

4. Crude costs will move up slightly faster than product prices. However, increased demand and lower refinery operating costs should help maintain margins.

5. Product imports will move up along with demand, increasing 7.6% to 2.48 million b/d. Product imports could be higher if import prices are competitive.

6. Petrochemical demand will continue to move up over the forecast period. Continued growth in economic activity will boost product demand.

7. Plans to add petrochemical capacity could result in a renewed excess capacity problem by the end of the forecast period.

8. The need for additional capacity and capacity modernization will boost capital spending for both refining and petrochemicals.

9. Environmental concerns could result in additional operating problems and additional investment requirements for the refining and petrochemical industries.

THE OUTLOOK — REFINING & PETROCHEMICALS

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
U.S. domestic demand (thousand barrels/day)	17,283	17,560	17,830	18,070	18,410	18,660	18,910	+1,350	+ 7.7
U.S. refining capacity (thousand barrels/day)	15,927	15,625	15,640	15,800	15,960	16,120	16,280	+655	+4.2
Crude runs (thousand barrels/day)	13,246	13,445	13,650	13,830	14,090	14,280	14,470	+1,025	+7.6
Input to distillation units (thousand barrels/day)	13,447	13,620	13,820	14,000	14,260	14,470	14,660	+1,040	+7.6
Refinery utilization rate (%)	84.4	87.2	88.4	88.6	89.3	89.8	90.0	+2.8	+3.2
Product imports (thousand barrels/day)	2,293	2,305	2,320	2,345	2,400	2,440	2,480	+175	+7.6
Product imports % of domestic demand	13.3	13.1	13.0	13.0	13.0	13.1	13.1	—	—
CAPITAL SPENDING ($ million)									
Refining	2,874	3,179	3,340	3,420	3,600	3,750	3,900	+721	+22.7
Petrochemical	1,962	2,927	3,220	3,380	3,480	3,550	3,660	+733	+25.0
PRICES									
Refinery acquisition cost: ($/barrel)									
Domestic	14.76	17.30	17.15	18.20	20.35	22.10	23.30	+6.00	+34.7
Imported	14.64	17.60	17.45	18.50	20.65	22.40	23.60	+6.00	+34.1
Composite	14.71	17.45	17.30	18.35	20.40	22.30	23.45	+6.00	+34.4
Motor gasoline ($/gallon)	0.963	1.085	1.075	1.115	1.180	1.245	1.305	+0.220	+20.3
Distillate fuel oil									
Home heating ($/gallon)	0.814	0.865	0.860	0.900	0.955	1.005	1.055	+0.190	+22.0

TRANSPORTATION

■

The changes in the transportation portion of the oil and gas industry are related to the location and volume of production and the location and level of consumption. The location and volume of crude oil and natural gas production are constantly changing throughout the world and within the U.S. The level and location of consumption is also changing with changes in economic activity. These changes also vary throughout the world and within the U.S. Over the past ten years the changes have been quite dramatic.

The level of activity in the transport sector is dependent upon the volume and location of the crude oil, petroleum products or natural gas to be moved. With the location of production, processing, and consumption continually changing, distribution patterns are constantly changing. Shifting distribution patterns change transport needs and operations even if volumes are not increasing. This is true for all aspects of transport: pipelines, water-going vessels, tanker trucks, or trains.

REVIEW

Over the past ten to fifteen years substantial changes have been posted in the level of production, consumption, and import/export levels of both crude oil and natural gas.

Many of the changes were very dramatic. Demand for petroleum products in the U.S. dropped 3.616 million b/d between 1978 and 1982. Then between 1982 and 1988 the trend in demand reversed and it moved up, increasing 2.052 million b/d. These large swings in demand for products obviously had an impact on product distribution patterns and transport requirements in the U.S.

On the production side of the industry the swings were also dramatic. With the rapid rise in prices U.S. output of crude oil moved up from 8.132 million b/d in 1976 to a recent peak of 8.971 million b/d in 1985. Then after prices plummeted in 1986 crude production started to slide, and by 1988 had slipped to an average of 8.14 million b/d. Over this period Alaskan production moved up steadily from 173,000 b/d in 1976 to 2.017 million b/d in 1988.

Import levels also went through some large changes over this period. Crude oil imports moved up from 3.244 million b/d in 1973 to 6.615 million b/d in 1977 and 6.519 million b/d in 1979. Then as U.S. demand slipped, crude imports fell sharply to 3.201 million b/d in 1985. These huge changes in import levels had a tremendous impact on the international crude oil tanker business.

And the dramatic shifting in import levels has not ceased. Imports have been moving up rapidly since 1985. Crude imports moved up to 5.107 million b/d in 1988.

These sharp swings in product demand, crude production, and imports have resulted in substantial alterations in distribution and transport operations and facilities.

Natural gas has also gone through some sharp shifts in consumption, production and imports. U.S. consumption of natural gas ranged from 19.4 to 20.2 tcf between 1975 and 1981. Consumption started to fall in 1982 and dropped as low as 16.2 tcf in 1986. But with lower prices and increased economic activity this trend also reversed. Natural gas consumption is now on the rise, and reached 17.933 tcf in 1988.

Marketed production in the U.S. followed a somewhat similar pattern. Domestic marketed production fell from 20.2 tcf in 1980 to 16.8 tcf in 1986. Domestic production has moved up the last few years and reached 17.449 tcf in 1988.

Imports of natural gas have also changed substantially. Imports averaged around 950 bcf from 1974–1985. Imports fell to 750 bcf in 1986. But then along with the increase in U.S. consumption, imports moved up to 992 bcf in 1987, and 1,283 bcf in 1988.

Changes in the location of production and consumption have accompanied these sharp swings in volume. And all of these changes have required adjustments in transport. These many changes end up requiring additional new investment in the transport sector of the oil and gas industry. Investment has continued at a good pace even though activity levels have changed dramatically. The new investment encompassed additions and changes in the capacity of all forms of transport: pipelines, water carriers, motor carriers and railroad cars.

Reviewing transport statistics shows how the traffic has changed in volume and how it has shifted between types of carriers. The total ton miles of crude oil and petroleum products carried in U.S. domestic transportation moved up steadily from 1972 through 1980. During this period it increased 48.5% from 838.8 billion ton miles in 1972 to a peak of 1,245.3 billion ton miles in 1980.

Ton miles in transport then declined slightly and averaged 1,220 billion ton miles from 1981–1983. But then in 1984 transport ton miles dropped rather sharply to 1,180.2 billion ton miles in 1984, down 5.2% from the peak. It moved up slightly to 1,195.5 billion ton miles in 1985, due to an increase in crude oil transport. It fell off in 1986 to 1,187.8 billion ton miles as crude production fell. But then transport volume rebounded back to 1,195.8 billion ton miles in 1987.

Crude oil transported constituted 60.5% of the total in 1980. This was up from 43.2% in 1972. It moved up slightly to 65.8% in 1985, slipped to 63.3% in 1986 and then back up to 64.2% in 1987. The sharp increase in crude oil ton miles is due to increased Alaskan production. The shifts in the level of product transport is related to the changing product demand levels.

Movement of crude oil has followed a different pattern than that for overall crude and petroleum products. Transport of crude oil moved up to a peak of 806.1 billion ton miles in 1983. It dropped to 748.4 billion ton miles in 1984 and than moved up to 786.2 billion ton miles in 1985. It fell to 751.3 billion ton miles in 1986 but then increased to 767.3 billion ton miles in 1987.

For crude oil carried in domestic transport, pipelines and water

TOTAL CRUDE PETROLEUM AND PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude and products Ton miles	PIPELINES		WATER CARRIERS		MOTOR CARRIERS*		RAILROADS	
		Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total
1972	838.8	475.8	56.73	330.0	39.34	23.0	2.74	10.0	1.19
1973	843.6	507.0	60.10	296.8	35.18	25.0	2.96	14.8	1.76
1974	847.7	506.0	59.69	297.0	35.04	29.0	3.42	15.7	1.85
1975	846.7	507.0	59.88	298.0	35.20	27.6	3.26	14.1	1.66
1976	867.7	515.0	59.35	306.9	35.37	32.5	3.75	13.3	1.53
1977	923.4	546.0	59.13	333.3	36.09	29.6	3.21	14.5	1.57
1978	1,160.2	585.8	50.49	530.6	45.73	30.6	2.64	13.2	1.14
1979	1,174.8	608.3	51.78	522.9	44.51	30.1	2.56	13.5	1.15
1980	1,245.3	588.2	47.24	617.8	49.61	26.8	2.15	12.5	1.00
1981	1,218.4	563.7	46.27	617.2	50.66	24.9	2.04	12.6	1.03
1982	1,218.2	565.7	46.44	616.9	50.64	22.7	1.86	12.9	1.06
1983	1,223.5	556.1	45.45	630.5	51.53	25.1	2.05	11.8	0.97
1984	1,180.2	568.1	48.14	570.7	48.36	29.2	2.47	12.2	1.03
1985	1,195.5	564.3	47.20	590.4	49.39	28.7	2.40	12.1	1.01
1986	1,187.8	577.9	48.65	568.1	47.83	29.7	2.50	12.1	1.02
1987	1,195.8	586.8	49.07	566.5	47.37	30.4	2.54	12.1	1.01

TOTAL CRUDE PETROLEUM CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total crude Ton miles	PIPELINES		WATER CARRIERS		MOTOR CARRIERS*		RAILROADS	
		Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total
1972	362.0	284.5	78.6	76.0	21.0	1.0	0.3	0.5	0.1
1973	363.2	302.0	83.1	58.8	16.1	1.3	0.4	1.1	0.4
1974	358.9	303.0	84.4	53.0	14.3	1.3	0.4	1.6	0.4
1975	331.5	288.0	86.9	40.6	12.2	1.4	0.4	1.5	0.5
1976	343.8	303.0	88.1	37.8	11.0	2.1	0.6	0.9	0.3
1977	392.5	326.6	83.2	63.1	16.1	2.0	0.5	0.8	0.2
1978	623.5	359.5	57.7	261.3	41.9	2.0	0.3	0.7	0.1
1979	640.6	372.2	58.1	265.5	41.4	2.3	0.4	0.6	0.1
1980	753.0	362.6	48.2	387.4	51.4	2.5	0.3	0.5	0.1
1981	740.7	333.1	45.0	404.9	54.6	2.2	0.3	0.5	0.1
1982	770.2	335.1	43.5	432.7	56.2	2.0	0.2	0.4	0.1
1983	806.1	332.4	41.2	471.2	58.5	2.0	0.2	0.5	0.1
1984	748.4	333.0	44.5	412.6	55.1	2.2	0.3	0.6	0.1
1985	786.2	334.4	42.5	449.2	57.2	1.8	0.2	0.8	0.1
1986	751.3	335.2	44.6	413.6	55.1	1.7	0.2	0.8	0.1
1987	767.3	341.5	44.5	423.3	55.2	1.6	0.2	0.9	0.1

TOTAL PETROLEUM PRODUCTS CARRIED IN DOMESTIC TRANSPORTATION

By mode of transportation
(Billions of ton miles)

Year	Total petroleum products Ton miles	PIPELINES		WATER CARRIERS		MOTOR CARRIERS*		RAILROADS	
		Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total	Ton miles	Percent of total
1972	476.8	191.3	40.1	254.0	53.3	22.0	4.6	9.5	2.0
1973	480.4	205.0	42.7	238.0	49.5	23.7	4.9	13.7	2.9
1974	488.8	203.0	41.5	244.0	49.9	27.7	5.7	14.1	2.9
1975	515.2	219.0	42.5	257.4	50.0	26.2	5.1	12.6	2.4
1976	523.9	212.0	40.5	269.1	51.4	30.4	5.8	12.4	2.3
1977	530.9	219.4	41.3	270.2	50.9	27.6	5.2	13.7	2.6
1978	536.7	226.3	42.2	269.3	50.2	28.6	5.3	12.5	2.3
1979	534.2	236.1	44.2	257.4	48.2	27.8	5.2	12.9	2.4
1980	492.3	225.6	45.8	230.4	46.8	24.3	5.0	12.0	2.4
1981	477.7	230.6	48.3	212.3	44.4	22.7	4.8	12.1	2.5
1982	448.0	230.6	51.5	184.2	41.1	20.7	4.6	12.5	2.8
1983	417.4	223.7	53.6	159.3	38.2	23.1	5.5	11.3	2.7
1984	431.8	235.1	54.4	158.1	36.6	27.0	6.3	11.6	2.7
1985	409.3	229.9	56.2	141.2	34.5	26.9	6.6	11.3	2.7
1986	436.5	242.7	55.6	154.5	35.4	28.0	6.4	11.3	2.6
1987	428.5	245.3	57.2	143.2	33.4	28.8	6.7	11.2	2.6

*Estimate

Source: Association of Oil Pipelines

OIL/WORLD TANKER FLEET, BY SIZE

(Million DWT)

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1987 share of total	% change 87/77
10-25,000 dwt	16.1	14.8	14.2	14.1	13.8	13.5	13.0	12.8	12.3	12.4	11.6	4.8	−28.0
25-45,000 dwt	26.6	24.6	24.2	24.6	26.0	27.2	27.4	26.3	25.8	26.3	28.8	12.0	+8.3
45-65,000 dwt	18.2	16.1	15.3	16.1	16.6	16.1	15.3	15.7	15.0	14.2	14.9	6.2	−18.1
65-125,000 dwt	54.2	50.8	51.2	52.5	55.4	51.8	48.4	46.2	44.4	46.6	43.9	18.3	−19.0
125-200,000 dwt	32.3	33.3	33.4	33.0	31.2	30.2	28.8	28.9	28.4	27.5	28.4	11.9	−12.1
200-320,000 dwt	156.6	157.4	157.7	155.4	146.5	134.5	120.4	111.6	94.9	90.6	88.8	37.1	−43.3
320,000 dwt and over	28.5	31.5	31.9	29.1	30.7	30.4	29.9	28.2	26.0	23.4	23.0	9.7	−19.3
Total World	332.5	328.5	327.9	324.8	320.2	303.7	283.2	269.7	246.8	241.0	239.4	100.0	−28.0

Source: British Petroleum and Author's estimate 1987

PIPELINE CONSTRUCTION—1989 AND BEYOND*

Area	†4-10 in.	12-20 in.	22-30 in.	Larger than 30 in.	Total
	Miles				
GAS PIPELINES					
U.S.	746	2,559	3,653	2,326	9,284
Canada	1,655	1,939	1,660	2,979	8,233
Latin America	806	314	629	666	2,415
Asia-Pacific	690	953	914	1,775	4,332
Western Europe	1,119	640	438	910	3,107
Middle East	0	0	0	0	0
Africa	48	8	350	584	990
Total gas	**5,064**	**6,413**	**7,644**	**9,240**	**28,361**
CRUDE PIPELINES					
U.S.	240	61	267	525	1,093
Canada	136	12	0	0	148
Latin America	9	70	67	165	311
Asia-Pacific	20	23	0	409	452
West Europe	13	78	73	0	164
Middle East	0	0	56	820	876
Africa	0	0	26	239	265
Total crude	**418**	**244**	**489**	**2,158**	**3,309**
PRODUCT PIPELINES					
U.S.	549	968	0	0	1,517
Canada	78	35	0	0	113
Latin America	110	731	0	0	841
Asia-Pacific	40	0	150	0	190
West Europe	36	15	0	0	51
Middle East	0	0	0	34	34
Africa	0	309	0	0	309
Total products	**813**	**2,058**	**150**	**34**	**3,055**
NON-COMMUNIST WORLD TOTALS					
Gas	5,064	6,413	7,644	9,240	28,361
Crude	418	244	489	2,158	3,309
Product	813	2,058	150	34	3,055
Total	**6,295**	**8,715**	**8,283**	**11,432**	**34,725**

*Projects planned and under way in 1989 and scheduled for completion beyond 1989. †Includes some projects of less than 4 in. diameter.

Source: Oil & Gas Journal

carriers accounted for 99.7% of total ton miles moved. This has not changed much over the past fifteen years. Motor carriers and railroads carry a very small portion of crude oil moved.

There has been a shift in crude transport from pipelines to water carriers. In 1977 pipelines carried 83.2% of the crude and water carriers 16.1%. Due to the increased volumes of crude moved long distances by water from Alaska this shifted to 57.7% pipeline and 41.9% water carrier in 1978. In 1985 this had moved to 42.5% pipeline and 57.2% water carrier. In 1986 it was 55.1% water carrier and 44.6% pipeline. And in 1987 it was 55.2% water carrier and 44.5% pipelines.

The total volume of crude oil carried in transport by pipelines also fell. It was at a peak of 372.2 billion ton miles in 1979. It dropped to 332.4 billion ton miles in 1983. It has been moving up slowly since then. In 1987 it was back up to 341.5 billion ton miles. Water carrier crude oil volume hit a peak of 471.2 billion ton miles in 1983. It fell to 413.6 billion ton miles in 1986. It was up to 423.3 billion ton miles in 1987.

Total ton miles of petroleum products carried in domestic transport peaked in 1978, at 536.7 billion ton miles. That was the year of peak domestic demand. This moved down to 409.3 billion ton miles in 1985, down 23.7%. It then moved back up to 436.5 billion ton miles in 1986, but slipped to 428.5 billion ton miles in 1987. The increase is a reflection of the increased demand, but the pattern of transport volumes is erratic.

Pipelines and water carriers accounted for 90.6% of the product transport in 1987. Motor carriers accounted for 6.7% and railroads 2.6%. Much of the short haul and smaller volumes are carried by motor carriers. Motor carriers and railroads also service areas where pipelines and water carriers do not or can not provide service.

Since the peak of transport of

petroleum products in 1978, the pipeline volume has decreased slightly and the percentage has moved up considerably. The total pipeline volume was 236.1 billion ton miles in 1979. It dipped to 223.7 billion in 1983 and then bounced back to 235.1 billion in 1984. It moved up to 242.7 billion ton miles in 1986, and 245.3 billion ton miles in 1987. The relative volume increased from 44.2% in 1979 to 56.2% in 1985, 55.6% in 1986, and 57.2% in 1987.

The water carrier volume peaked in 1977 at 270.2 billion ton miles of petroleum products. It fell to 141.2 billion ton miles in 1985. It recovered slightly to 154.5 billion ton miles in 1986. But then it slipped to 143.2 billion ton miles in 1987.

The reduction of the import of residual fuel oil from U.S. Caribbean Island refineries was a major factor in this decline. The percentage of products carried by water carriers fell from 50.9% in 1977 to 34.5% in 1985, 34.5% in 1986 and 33.4% in 1987.

Almost all natural gas is transported by pipeline. The change in the volume of overall domestic production and consumption is a major factor determining the transport level of natural gas. The location of production and consumption is also a major factor determining changes in natural gas transport.

The importation of natural gas can also be a factor. Changes in the volume and location of these imports influence decisions concerning pipeline volume and location. Almost all imports are presently from Canada via pipeline. However, there are some imports of LNG from Algeria and Indonesia.

PIPELINES. Between 1973 and 1982, total U.S. pipeline mileage increased from 419,464 miles to 459,548 miles. This was an increase of 40,084 miles, 9.6%. Gas pipeline mileage increased from 248,773 miles to 286,999 miles, an increase of 38,226 miles. The increase in gas pipelines accounted for 95.4% of the increase in total pipeline mileage. Liquids pipeline mileage was 172,549 miles in 1982, up only 1.1% from 170,691 miles in 1973.

Total interstate pipeline mileage in the U.S. peaked in 1982 at 459,548 miles. That was also the year of peak natural gas pipeline mileage of 286,999 miles, 62.5% of total mileage. Liquids pipeline mileage was 172,549 miles that year. Since that time total mileage has fallen, mainly because of a drop in gas pipeline mileage. The latest year for which data is available is 1987. In that year total mileage was 447,950 miles, down 11,598 miles from the peak. Gas pipeline mileage in 1987 was 280,085 miles, down 6,914 miles from the peak. Liquids pipeline mileage was 167,865 miles, down 4,684 miles from 1982. The peak year for liquids pipeline mileage was 1976, with 174,072 miles. Although pipeline mileage is down from the peak in 1982, it had been on the rise from 1984–1986. It moved up 19,864 miles over the 1984–1986 period. In 1987 it slipped again, falling 3,945 miles.

The change in total mileage does not reflect all total new construction. With changes in production and distribution patterns some old pipelines are shut down each year. Therefore, new construction includes more than just net additions. So these figures can be a bit misleading with respect to total pipeline construction activity. Even when total mileage was declining, there was ongoing construction activity. New discoveries of crude oil and natural gas and changing distribution patterns for petroleum products and natural gas require an ever changing pipeline network. Pipelines are added to new or expanding producing areas, and are shut down as areas are depleted. Population growth and movements, and changes in the level of economic activity result in new requirements for new distribution pipelines.

The level of expenditures on new pipeline construction activities is quite significant. Pipeline expenditures are a representation of the industry's perception of future long-term needs. Many pipeline projects are of a long duration and do not have an impact on immediate needs. Therefore, the relative level of spending is a good leading indicator of the expected changes in the level of activity in the oil and gas industry.

CAPITAL SPENDING. Industry capital expenditures for transportation requirements are spread over natural gas pipelines, crude oil pipelines, petroleum product pipelines, water transport vessels, railroad cars and motor carriers. However, the vast majority of the spending is for pipeline construction.

Capital spending on total U.S. pipeline construction increased from $672 million in 1972 to $7,390 million in 1982, an increase of 999.7% over the ten years. Spending on natural gas pipelines increased from $578 million in 1972 to $6,070 million in 1982, 950.2%. Crude and product pipeline outlays in 1982 were $1,320 million, up 1,304.3% from $94 million in 1972. Outlays for crude and product pipelines have been more volatile, reaching a peak of $2,949 million in 1976 when the Alaskan pipeline was under construction. After that project, the highest level of spending reached $2,456 million in 1983.

Pipeline spending fell following the downturn in demand and the drop in prices. Spending on crude oil pipelines, petroleum product pipelines and natural gas pipelines all dropped sharply. Total pipeline spending fell to $1,744 million in 1986 down 76.4% from 1982. Of the 1986 total, $1,309 million was for natural gas pipelines and $435 million for crude and products pipelines. Natural gas pipeline spending was down 78.4% from the 1982 level.

There was a shift in the trend in 1987. Total pipeline spending moved up to $2,289 million in 1987. Natural gas pipeline spending increased to $1,556 million and crude and product pipeline spending moved up to $733 million. Outlays slipped a bit in 1988 to $2,059 million. Natural gas pipeline spending moved up to $1,659 million and crude and product pipeline spending fell to $400 million.

Plans for 1989 outlays show a sharp drop to $1,420 million, due to a sharp drop in natural gas pipeline outlays. Spending on those pipelines will fall to $969 million. Capital spending on crude oil and product pipelines will be up however, increasing to $451 million.

Ocean-going tankers for the transportation of crude also represent huge investments. But during the period of a declining market, with substantially reduced demand, and therefore reduced import/export volumes, there was a massive surplus of tanker tonnage. The domestic industry also uses water carriers for a substantial proportion of crude oil and product transport. With reduced domestic demand, transport volumes moderated which reduced the need for additional investment in tankers.

Investment for other land transport and inland water transport represents smaller outlays and is less volatile. A reduction in expenditures due to lower demand levels was offset somewhat by increased expenditures due to changing patterns of distribution.

When demand was rising, capital expenditures on other modes of transport also moved up rapidly, increasing from $175 million in 1972 to $895 million in 1981, up 411.4%. When demand started to decline, outlays also started to fall. Investment in this sector dropped to $310 million in 1987. This was a decline of 65.4%. Investment rebounded in 1988 to $416 million. Plans for 1989 are for industry outlays of $542 million, up 74.8% from 1987. This is related to the rapid increase in demand for petroleum products.

TANKERS. A large portion of the outlays for other transport are for ocean-going tankers for crude transport. And spending for these tankers moves with the level of worldwide crude and product import/export trade.

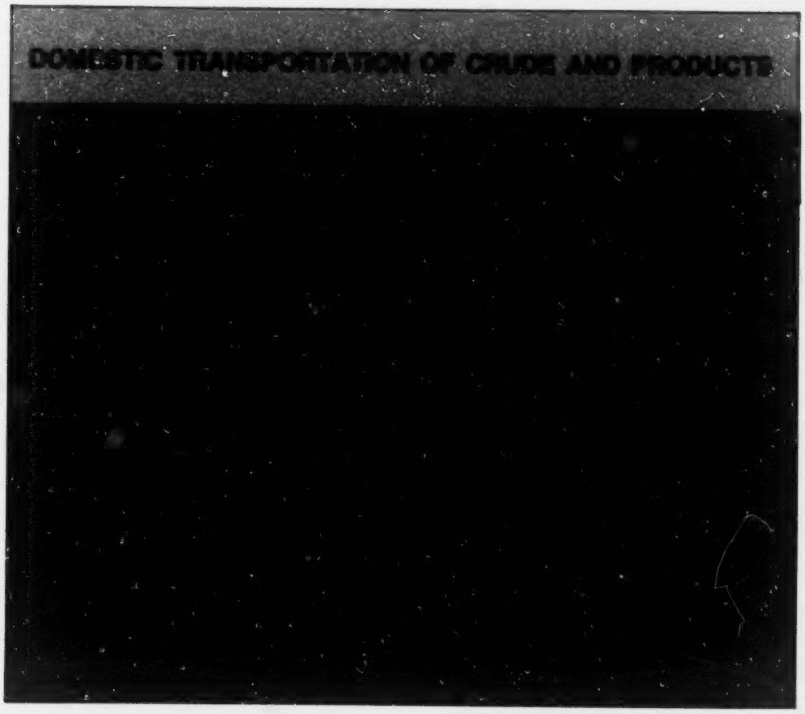
When imports fell sharply this had a major negative impact on the tanker industry. The worldwide tanker industry was severely depressed due to the sharp drop in trade, as demand fell following the crude price hike.

The tanker fleet fell from a peak of 332.5 million deadweight tons in 1977 to 239.4 million tons in 1987. This was a drop of 28%. And much of the existing tonnage was idle or under-utilized. The small size of the fleet reduction in 1987, only 1.6 million deadweight tons, was an indication that the size of the tanker fleet was in better balance with demand.

The adjustment took the shape of eliminating redundant VLCC tankers. They are used mainly for long-distance transport, and the long-haul volumes of crude from the Persian Gulf to the U.S. were cut sharply with the drop in imports. The industry is now concentrating on smaller and more flexible tankers. To hold down losses, many excess tankers were converted for other uses, such as offshore storage.

The development of the North Sea oil fields also had a substantial impact on the tanker industry. As these fields developed, Europe was transformed from long-haul tanker trade to short-haul. In the early and mid-1970's, Europe relied primarily on long-haul oil from the Persian Gulf. This oil moved in VLCC tankers through the Straits of Hormuz and around the Cape of Good Hope. With the North Sea fields, many of these tankers were no longer needed.

With increased worldwide demand and increased petroleum import/export trade the tanker fleet began to move back up in 1988 and 1989. The fleet moved up to 243.5 million dwt at end-1988 and to 246.6 million dwt at mid-1989. This is an indication that the picture is changing for the tanker fleet. Petroleum demand and imports are increasing worldwide. The increased import requirements



DOMESTIC TRANSPORTATION OF CRUDE AND PRODUCTS

are most dramatic for the U.S. And the U.S. import requirements appear to be the real key to the change in tanker needs.

Worldwide trade of oil fell off sharply from a peak of 35.35 million b/d in 1979 to a recent low of 24.12 million b/d in 1985. This was a decline of 31.8%, a drop of 11.23 million b/d in world trade volumes. But this has also been rebounding since the decline in prices and the increase in petroleum product demand. The worldwide trade volume moved up to 26.265 million b/d in 1986 on the strength of increased demand and increased U.S. imports. It fell to 24.59 million b/d in 1987 when prices rebounded and trade slowed. With reduced prices in 1988 the trade volume jumped to 27.377 million b/d. It is expected to be up again in 1989, due to increased demand and increased U.S. imports.

OUTLOOK

There will be a number of significant changes in the U.S. and worldwide oil and gas industry that will have a major impact on the transportation sector, over the forecast period 1989–1994.

The continued increase in economic activity will boost the demand for energy and for natural gas and petroleum products. The consuming areas are not generally the areas with the huge reserves and production. Therefore, increasing volumes of crude oil, natural gas and petroleum products will require transport throughout the 1989–1994 period.

Worldwide and U.S. demand for petroleum products will be increasing markedly over the next five years. World non-communist demand for petroleum products is projected to increase 8.5% between 1989 and 1994. Demand will move up 4.316 million b/d to 55.255 million b/d in 1994. U.S. demand for petroleum products will increase 7.7% to 18.910 million b/d. This is an increase of 1.35 million b/d over the next five years.

A large portion of the increase in consumption of petroleum products will take place in the industrial countries. Many of these countries have either low or declining rates of domestic production. There will also be substantial increases in demand in developing countries that have low levels of oil production. These needs can only be met by imported crude oil or petroleum products. Therefore, worldwide import/export petroleum trade will move up much faster than demand. The volume of world petroleum trade is projected to increase 20.5%, moving up 5.89 million b/d, to 34.635 million b/d. One of the major portions of this increase will be the jump in U.S. petroleum imports. U.S. imports will move up 25.6% to 10.245 million b/d in 1994. This is an increase of 2.085 million b/d. The U.S. increase will account for 35.4% of the increased volume in worldwide trade. And because of the distance required to bring imports to the U.S., it will account for a much larger proportion of the increased transport requirement.

This large increase in crude oil and petroleum product trade will require additional transport. There will be a substantial increase in requirements for ocean going vessels to handle the increased import/export trade. There will also be increased requirements for surface transport to move crude and products due to the increase in product consumption. And finally there will be a significant increase in demand for pipeline capacity. Additional pipelines will be required to move crude oil, petroleum products and natural gas.

Demand for natural gas is expected to increase worldwide. In the U.S., demand will move up 5.9% over the forecast period, moving up to 19.245 tcf in 1994. U.S. domestic production will increase 4.3% to 18.395 tcf. And imports will move up 24.1% to 1.65 tcf in 1994.

U.S. pipeline construction activity and investment may not return to boom levels of 1981-1983, but it is obvious that a substantial level of new construction is planned. The pipeline industry has been required to change substantially to adjust to changing expectations for the industry and changing requirements for pipeline transport. They will be required to adjust again. Demand for natural gas and crude oil are expected to increase during the forecast period and that will require additional pipelines.

The latest survey of pipeline construction plans listed plans for an additional 34,725 miles of pipeline to be constructed in the non-communist world in 1989 and the years after. A total of 11,894 miles is planned for the U.S. and 22,831 miles outside the U.S. This survey shows 34.3% of the construction planned for the U.S. In 1987 this survey showed 69.8% of the construction planned for the U.S. This is an indication of the industry shift to non-U.S. production activities.

The growing worldwide importance of the natural gas industry is reflected in the 28,361 miles of new gas pipeline planned. Of this total, 9,284 miles is planned for the U.S. and 19,077 miles outside the U.S. Canadian plans are for an additional 8,233 miles.

A total of 3,309 miles of new crude pipeline is planned with 1,093 miles in the U.S. and 2,216 miles outside. There are 876 miles planned for the Middle East. Total product pipeline mileage planned is 3,055 miles with 1,517 miles in the U.S. and 1,538 miles outside the U.S.

The U.S. leads the way in construction plans for all three types of pipelines. Plans call for construction in the U.S. of 9,284 miles of gas pipelines, 1,093 miles of crude pipelines and 1,517 miles of product pipelines.

Canada is a close second in plans for gas pipeline construction with 8,233 miles. Much of this is for the U.S. export market. Asia Pacific follows with 4,332 miles. Next is Western Europe with 3,107 miles planned. Latin America has plans for 2,415 miles of gas pipelines. Plans call for 990 miles in Africa. There were no recorded plans for additional gas pipelines in the Middle East. This is surprising since a substantial portion of the worlds reserves are in the Middle East. However, it is quite a distance from the consuming areas of the world.

The Middle East is second in plans for crude pipelines with 876 miles. This is followed by Asia Pacific with 452 miles. There are 311 miles of crude pipelines planned for Latin America and 265 miles in Africa. Western Europe is next with plans for 164 miles and Canada trails with 148 miles planned.

Latin America is second in plans for product pipelines with 841 miles. Next is Africa at 309 miles. Asia Pacific has plans for 190 miles.

All of these changes and additions are reflected in the projected increase in transport capital expenditures over the 1989-1994 period.

Total U.S. capital expenditures for new pipeline construction is expected to increase 69% over the forecast period to $2,400 million in 1994. This is an increase of $980 million in the level of annual spending. Outlays for gas pipelines will increase 88.3% up $856 million to $1,825 million in 1994. Crude and product pipeline construction will increase 27.5%, up $124 million to $575 million in 1994. Increased exploration and drilling activity, increased demand for petroleum products, and increased imports will all have an impact on supply patterns and therefore on the level of pipeline construction.

U.S. capital expenditures for other transport needed by the industry will also be affected by increased activity and demand. Increased demand will call for increased transport of products to areas of consumption. Increased worldwide trade will call for additional ocean going tankers. Capital spending for other transport will move up 84.5%, to $1,000 million in 1994. This is an increase of $458 million in the level of annual investment.

The relatively low price level expected to prevail throughout the forecast period will stimulate activity in all segments of the oil and gas industry, including transport.

THE OUTLOOK — TRANSPORTATION

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
CAPITAL SPENDING - U.S. (Million $)									
Natural gas pipelines	1,659	969	1,355	1,600	1,755	1,790	1,825	+856	+88.3
Crude and product pipelines	400	451	475	500	525	550	575	+124	+27.5
Other transport	416	542	600	700	800	900	1,000	+458	+84.5
Total transportation	**2,475**	**1,962**	**2,430**	**2,800**	**3,030**	**3,240**	**3,400**	**+1,438**	**+73.3**
WORLD PETROLEUM TRADE (thousand barrels/day)	27,377	28,745	29,645	30,785	32,395	33,565	34,635	+5,890	+20.5
TOTAL U.S. CRUDE IMPORTS Industry and SPR (thousands barrels/day)	5,107	5,855	6,285	6,685	7,190	7,245	7,765	+1,910	+32.6
U.S. PRODUCT IMPORTS (thousand barrels/day)	2,293	2,305	2,320	2,345	2,400	2,440	2,480	+175	+ 7.6

TRANSPORTATION—KEYS TO THE FUTURE

1. U.S. and worldwide demand for petroleum products, crude oil and natural gas will increase over the forecast period.

2. The increased demand will result in a substantial increase in the worldwide petroleum import/export trade. Declining U.S. crude production will increase the volume that must be supplied via worldwide import/export trade.

3. Transport requirements in the U.S. will change markedly during the forecast period. U.S. demand for petroleum products and natural gas will move up over the 1989-1994 forecast period. This will increase the volume in transport.

4. All of these increases in consumption, production and trade will boost requirements for all types of transport: tankers, pipelines, and motor and rail transport.

5. The increased transport requirements will result in increased capital spending in this sector throughout the forecast period. Annual U.S. outlays will be up 73.3% in 1994.

NATURAL GAS

■

There is a great deal of optimism about the future of the U.S. natural gas industry. The optimism seems to be based upon the future needs for an abundant, efficient, clean burning, non-polluting fuel to power future U.S. economic growth.

Activity in the upstream sector of the natural gas industry is somewhat depressed at the present time due to low gas prices. But a turning point may have been reached in the natural gas industry. And the industry could be poised for a substantial period of sustained growth.

The natural gas industry lagged behind other sectors of the overall energy industry in adjusting to the volatile price changes of the late 1970's and 1980's. The slow adjustment to the price swings had an adverse impact on the natural gas industry. Natural gas lost market share in the energy business to competing fuels, and this resulted in a drop in consumption of natural gas.

Prices and demand for energy have exhibited a great deal of volatility over the recent past. And structural changes, such as multi-fuel capacity and conservation programs, have increased the level of competition in the energy business. Faced with the substantial volatility and increased com-

UNITED STATES NATURAL GAS SUPPLY AND DEMAND

	Billion cu ft					
	1975	**1980**	**1984**	**1986**	**1987**	**1988**
Marketed production	20,109	20,180	18,230	16,791	17,349	17,449
Supplemental gas	0	155	110	113	101	143
Imports	953	985	843	750	992	1,283
Losses (including extraction)	(1,107)	(1,417)	(980)	(1,227)	(1,244)	(744)
Total supply	**19,955**	**19,903**	**18,203**	**16,427**	**17,198**	**18,131**
Exports	73	49	55	61	54	74
Stock change	344	(23)	(197)	145	6	124
Domestic demand	**19,538**	**19,877**	**17,951**	**16,221**	**17,138**	**17,933**
	Sector demand (Trillion BTU)					
Residential & commercial	7,581	7,540	7,291	6,824	6,938	7,499
Industrial	8,532	8,394	7,449	6,693	7,264	7,715
Transportation	595	650	545	499	535	561
Electric utility	3,240	3,810	3,220	2,691	2,935	2,719
Total	**19,948**	**20,394**	**18,505**	**16,707**	**17,672**	**18,494**

Source: Energy Information Administration

NATURAL GAS PROCESSING AND LIQUIDS PRODUCTION

	Billion cu ft			Natural gas liquids	
	Gross gas production	**Gas processed**	**Percent processed**	**Gallons per Mcf of gas processed**	**Liquids produced (000 b/d)**
1970	23,786	18,509	77.8	1.376	1,661
1971	24,088	19,252	79.9	1.348	1,693
1972	24,016	19,906	82.9	1.347	1,744
1973	24,067	19,679	81.8	1.353	1,737
1974	22,850	18,684	81.8	1.386	1,689
1975	21,104	17,748	84.1	1.410	1,632
1976	20,944	17,718	84.6	1.388	1,604
1977	21,097	17,570	83.2	1.400	1,618
1978	21,309	17,012	79.8	1.381	1,567
1979	21,883	16,400	75.0	1.481	1,585
1980	21,870	15,750	72.0	1.537	1,576
1981	21,587	14,817	68.6	1.664	1,609
1982	20,210	14,164	70.1	1.678	1,550
1983	18,597	13,173	70.8	1.814	1,559
1984	20,192	13,946	69.1	1.792	1,630
1985	19,534	14,145	72.4	1.744	1,609
1986	19,063	13,985	73.4	1.700	1,551
1987	20,056	15,073	76.1	1.622	1,595
1988	20,425	15,316	75.0	1.629	1,625

Source: Oil & Gas Journal and Energy Information Administration.

petition, it is necessary to be able to adjust rapidly to changing conditions, in order to retain market share.

There are two major problem areas that have confronted the natural gas industry and made the adjustment process more difficult. First, there are the myriad government regulations and controls to contend with. Second, there is the structure of the industry and the changing relationship between producers, pipeline companies and consumers.

Government regulation of the natural gas industry has been a major impediment to its ability to adjust to changing conditions and compete effectively. Government controls and regulations tend to distort the economics and interfere with the market mechanism. Government price controls do not allow for a self-correcting mechanism that would enable rapid movement to demand and supply equilibrium at a market clearing price.

The long-term contractual arrangements that were, in the past, an integral part of the industry trading operation also proved to be a problem area when rapid price adjustment was required. Resolving this problem has prevented the industry from concentrating resources and energy on resolving other problems facing the industry. But this restructuring is expected to be with the industry for a long time.

In addition, the natural gas industry has had to contend with the "gas bubble." The "gas bubble" is the natural gas industry's large excess gas deliverability. It is comparable to OPEC's excess capacity and it also puts downward pressure on prices. The gas bubble developed because demand fell sharply due to higher prices, and the industry was not able to adjust rapidly to the change.

There are signs that some of these problems are being resolved, and this may help to eliminate some of the gas deliverability problem and restore growth to the industry.

The duration of the gas bubble is difficult to predict. Some experts believe it has already disappeared. Natural gas now finds itself in a very competitive energy market. In order to try to retain markets, the natural gas industry will have to become more aggressive in marketing and flexible in pricing. Prices will have to be adjusted quickly to meet the competition from other fuels. One thing that could help greatly would be the elimination of confusing and inefficient government controls. Returning natural gas to a more market-oriented structure would lead quickly to a stronger, more efficient industry.

U.S. GAS PRODUCTION AND RESERVES

	1973	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	% change 88/73
	(Billion cu ft)													
Marketed production:														
Texas	8,514	7,051	6,548	7,175	7,116	6,910	6,469	5,939	6,185	6,053	6,152	6,126	6,211	−27.0
Louisiana	8,242	7,215	7,476	7,266	6,940	6,780	6,172	5,332	5,825	5,013	4,895	5,123	5,093	−38.2
Others	5,891	5,759	5,950	6,030	6,124	6,266	5,879	5,551	6,220	6,132	5,744	6,100	6,195	+5.2
Total U.S.	**22,648**	**20,025**	**19,974**	**20,471**	**20,180**	**19,956**	**18,520**	**16,822**	**18,230**	**17,198**	**16,791**	**17,349**	**17,449**	**−23.0**
	(Billion cu ft)													
Reserves:														
Total U.S.	249,950	208,878	200,302	194,917	199,021	201,730	201,512	200,247	197,463	193,369	191,586	187,211	187,200	−25.1
	(Years)													
Reserves/production ratio:														
Total U.S.	11.04	10.43	10.03	9.52	9.86	10.11	10.88	11.90	10.83	11.24	11.41	10.79	10.73	

Source: American Petroleum Institute; Energy Information Administration

REVIEW

GAS DELIVERABILITY. The substantial increase in energy and natural gas prices in the first half of this decade had a major unsettling impact on the natural gas industry. Prior to the jump in prices, demand for natural gas moved up or down with movements in the level of economic activity. Natural gas was priced so that it held an advantage over competing fuels in certain key sectors of the economy and/or areas of the country. This enabled natural gas to maintain a base demand load, while the industry attempted to expand into other areas and markets.

Natural gas prices followed other energy prices and moved up slowly in the early 1970's. As other energy prices moved up at an accelerated pace natural gas prices followed. On the supply side higher natural gas prices stimulated exploration and drilling for natural gas. And as a result, natural gas deliverability increased. At the same time, on the demand side, higher prices led to conservation and increased competition from competing fuels. And demand for natural gas moved lower.

Although other energy prices such as crude oil started falling in 1981, natural gas prices continued to move up until 1984. At higher prices natural gas faced even greater competition. The price advantage that gas held in certain sectors was diminished. Natural gas lost some base load to conservation and still more to other fuels.

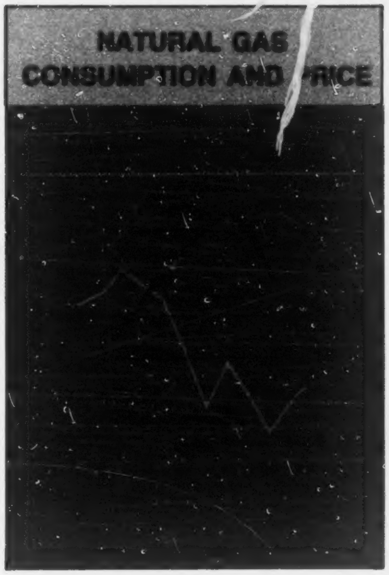
These changes in the market resulted in the development of a substantial "gas bubble" with available deliverable supply much greater than demand. Surplus deliverability was in excess of 20% in 1983. At that time, dry gas deliverability was estimated at around 20,200 bcf. And U.S. dry gas production was only 16,033 bcf. This left a surplus of 4,167 bcf.

The deliverability surplus has been reduced in recent years. The drop is primarily due to a decline in deliverability, but demand has also been moving up. Dry gas deliverability in 1987 was estimated at 18,600 bcf. Estimated deliverability fell to 18,000 bcf in 1988 and to 17,500 bcf in 1989. At the same time there was an increase in dry gas production to 16,536 bcf in 1987 and to 16.632 bcf in 1988. These production increases also have helped to reduced the surplus. The result of these moves has been a drop in the deliverability surplus to an estimated 2,064 bcf in 1987 and only 1,368 bcf in 1988. The surplus is projected to slip to 830 bcf in 1989 if there is an increase in U.S. natural gas production. By 1990 the gap will probably be closed.

PRICES. Changing natural gas and other energy prices have been a major factor affecting the natural gas industry over the past fifteen years.

Over the ten-year period 1973–1982, the average wellhead price of natural gas went up 1,118.2% from $0.22/mcf in 1973 to $2.46/mcf in 1982. That is an average annual increase of 30.8%. Over this period the relationship between crude oil and natural gas prices changed markedly. The cost of natural gas relative to crude oil increased about 50% over this period. As a result natural gas lost some competitive advantage and began to lose share of the energy market.

Natural gas demand began to fall in 1981 and 1982. But even in the face of falling demand, prices continued to move up throughout 1981 and 1982. Long-term contracts, entered into when the



MARKETED PRODUCTION OF NATURAL GAS BY STATES*

State	1982	1983	1984	1985	1986	1987	1988
	(Billion cu ft)						
Alabama	75.0	90.8	101.8	107.3	107.2	117.2	129.5
Alaska	264.4	276.7	289.1	321.3	304.8	359.8	392.2
Arkansas	124.6	127.6	135.2	155.1	131.1	141.2	146.9
California	3384.0	415.3	476.3	491.3	462.2	424.6	398.9
Colorado	209.9	163.5	173.3	178.2	163.7	164.6	181.7
Florida	22.5	21.1	12.6	10.5	8.8	8.3	7.8
Kansas	429.6	434.7	466.0	512.9	465.7	457.1	479.4
Louisiana	6,171.6	5,332.1	5,825.1	5,013.7	4,895.4	5,122.5	5,093.1
Michigan	153.1	138.9	144.5	131.9	127.3	147.0	141.9
Mississippi	167.2	151.2	157.9	144.2	140.8	139.7	130.3
Montana	56.5	52.0	51.5	52.5	46.6	46.5	51.3
New Mexico	991.2	895.3	957.4	905.3	702.6	823.8	783.1
North Dakota	53.8	69.3	70.5	72.6	55.1	62.3	57.7
Oklahoma	1,934.4	1,730.1	1,985.9	1,936.3	1,917.5	2,004.8	2,039.1
Texas	6,468.8	5,938.6	6,185.0	6,052.7	6,151.8	6,126.3	6,211.3
Utah	94.3	63.2	74.7	83.4	90.0	87.2	101.0
W. Virginia	150.9	130.1	143.7	144.9	135.4	160.0	157.4
Wyoming	424.7	444.0	516.7	416.6	403.3	498.0	487.4
Others	343.4	347.8	462.4	467.3	481.6	457.6	458.6
Total	18,519.7	16,822.1	18,229.6	17,198.0	16,790.9	17,348.5	17,448.6
Volume change	−1,436	−1,698	1,407	−1,032	−407.1	557.6	100.1
Percent change	−7.2	−9.2	8.4	−5.7	−2.4	3.3	0.6

*Includes nonhydrocarbon gases.

Source: Energy Information Administration

outlook was for a future natural gas shortage, continued to push up prices. Because of the take-or-pay provisions in most of these contracts, when demand began to fall, it became advantageous for the pipelines purchasing gas to continue to take high-priced gas and curtail acceptance of the lower-priced gas. This aggravated the problem and drove the prices higher.

Even though the price of crude oil and heavy fuel oil was falling and demand for natural gas was declining, the price of natural gas continued to move up in 1983 and 1984. But price increases were somewhat more moderate during 1983 and 1984. The average wellhead price moved up 5.3% in 1983 to $2.59/mcf, and up a modest 2.7% in 1984 to $2.66/mcf. Over the entire span 1974 to the peak price year of 1984, the price increased $2.44/mcf.

Over that same period, the price paid for natural gas by electric utility plants, increased $3.37/mcf from $0.35/mcf in 1973 to $3.72/mcf in 1984. The residential price moved up $4.77/mcf from $1.29/mcf in 1973 to $6.06/mcf in 1984.

The price paid for natural gas by electric utilities moved up 963%, and the residential price for natural gas moved up 369.8% over the 1973–1984 period. These price increases led to a great deal of conservation and fuel switching. Faced with a rate of increase in natural gas energy costs of that magnitude, a major effort was made by all consumers to conserve on natural gas consumption.

In response to the falling prices of competing fuels and declining natural gas demand, natural gas prices started to fall in 1985. The price decline accelerated in 1986 and continued into 1987 and 1988. But as in the past, in 1986 the natural gas industry did not react quickly enough to the sharp drop in crude oil prices and demand and market share were lost. In mid-1986, for the first time on record, the price paid by steam electric utility plants for heavy oil fell below natural gas. The price per million BTU for heavy oil fell below natural gas in April 1986 and remained lower through October 1986. The price per million BTU for heavy oil fell as low as $1.841 in July 1986. The natural gas price in July was $2.161 per million BTU. As a result of this change in price relationships, natural gas lost market share to fuel oil in the utility sector in 1986.

In addition to competition from other fuels, increased gas to gas competition has been putting downward pressure on prices. With excess deliverability gas producers and distributors are competing with each other for the same customers. This has the effect of lowering gas prices without substantially increasing demand for natural gas.

However, the average U.S. wellhead price for natural gas moved

PRODUCTION, IMPORTS

	Total marketed prod.	Imports	Total new supply*	Imports % total supply
	(Billion cu ft)			
1973....	22,648	1,033	23,681	4.4
1974....	21,601	959	22,560	4.3
1975....	20,109	953	21,062	4.5
1976....	19,952	964	20,916	4.6
1977....	20,025	1,011	21,036	4.8
1978....	19,974	966	20,940	4.6
1979....	20,471	1,253	21,724	5.8
1980....	20,180	985	21,165	4.7
1981....	19,956	904	20,860	4.3
1982....	18,520	933	19,453	4.8
1983....	16,822	920	17,742	5.2
1984....	18,230	843	19,073	4.4
1985....	17,198	949	18,147	5.2
1986....	16,791	750	17,541	4.3
1987....	17,349	992	18,341	5.4
1988....	17,449	1,283	18,732	6.8

*Before losses

Source: Energy Information Administration

up slightly to $1.71/mcf in 1988. This modest increase was due to increased demand for natural gas. Demand was up 4.6% in 1988. The price in 1988 was down $0.95/mcf, 35.7%, from the peak of $2.66/mcf in 1984. The impact of the price drop is being felt in the consumption and production of natural gas, both of which are on the rise.

CONSUMPTION. Consumption of natural gas fell from 22.05 trillion cu. ft. in 1973 to 16.84 trillion cu.ft. in 1983, a drop of 23.6%. It rebounded to 17.95 trillion cu.ft. in 1984, an increase of 6.6% from the previous year. It dropped slightly to 17.28 trillion cu.ft. in 1985. It then fell sharply to 16.221 trillion cu.ft. in 1986.

The drop in gas prices and more aggressive marketing has helped boost consumption in 1987 and 1988. Consumption in 1987 jumped back up to 17.14 trillion cu.ft. And in 1988 it also moved up substantially to 17.93 trillion cu.ft. The increase in crude oil prices helped boost natural gas consumption in 1987. The competitive advantage of natural gas in the utility and heavy industry markets increased and there was a shift to natural gas as the fuel of choice.

Natural gas has held a cost advantage over heating oil in the residential market, and a cost advantage over residual fuel oil in the utility and industrial sectors. By 1982 a substantial portion of this cost advantage had eroded. Therefore, natural gas found itself facing competition it had not encountered before. In the residential sector, conversions from home heating oil to natural gas slowed. And in the industrial and utilities sectors, natural gas fell victim to the recession and to competition from other fuels. The Fuel Use Act which existed then also contributed to the problem. The regulations gave utilities and heavy industry low priority in the case of a natural gas supply curtailment. Without supply assurances utilities and industry sought other fuels. The Fuel Use Act also restricted expansion of gas generation facilities.

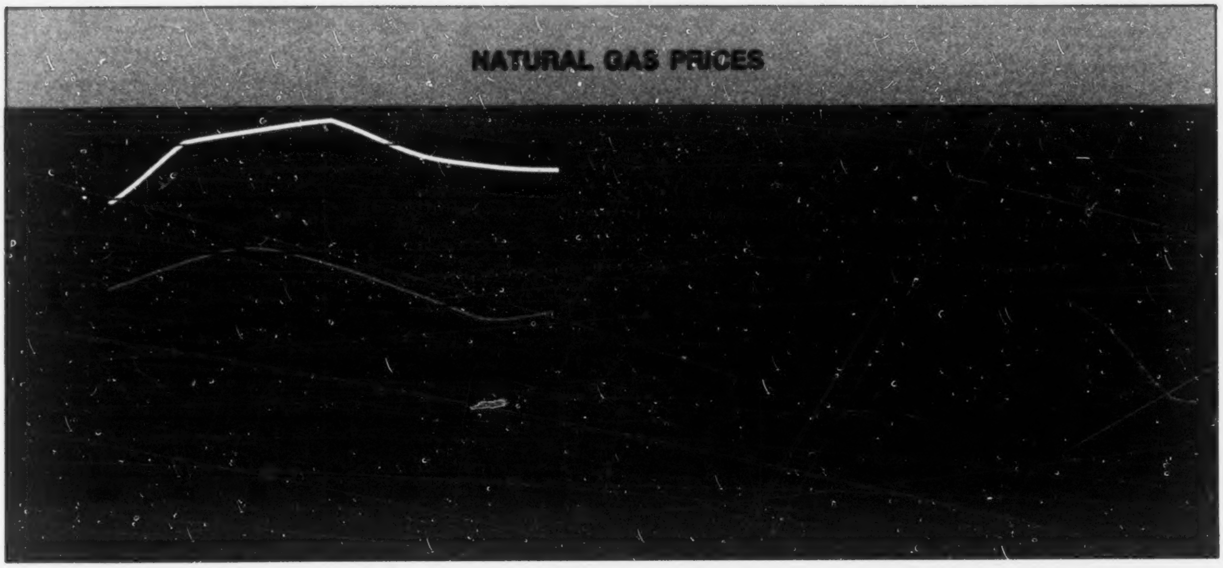
In addition, utilities and industry moved toward installing multiple fuel capabilities, so they would have the flexibility to take advantage of any price differential between fuels. The volume of multi-fuel capacity increased markedly because of the high cost of energy. This resulted in intense competition for natural gas in many of its historical markets. If energy prices move up again, multi-fuel capability may also become prevalent in future years for residential and commercial heating.

In order to compete, the gas industry has had to adjust prices to meet this fuel competition. And the recent natural gas price adjustments have increased its competitive position and stimulated consumption.

SUPPLY AND PRODUCTION. Marketed production of natural gas in the U.S. followed demand, falling from 22,648 billion cu.ft. in 1973 to 16,822 billion cu.ft. in 1983, down 25.7%. Production moved up in 1984 to 18,230 billion cu.ft., an increase of 8.4%. However, production fell again in 1985, down 5.7% to 17,198 billion cu.ft. Domestic production continued this downward movement falling to 16,791 billion cu.ft. in 1986. This was the lowest level of domestic marketed production since 1965.

With increased demand, production has moved up in 1987 and 1988. Production increased to 17,349 billion cu.ft. in 1987 and 17,449 billion cu.ft. in 1988.

When natural gas prices were rising there was no concern about the availability of natural gas. The higher gas prices stimulated the supply side for natural gas. Exploration and production activity moved up sharply during the drilling boom years 1979–1982. The number of gas wells completed moved up from 3,983 in 1971 to 19,742 in 1981 and 18,363 in 1982. And the number of completions has remained relatively high over the 1983–1984 period. Gas well completions dropped to 14,619 in 1983, then moved up to 17,201 in 1984. But gas well drilling



has slipped in recent years, falling to 12,875 in 1985, 8,096 in 1986 and 8,114 in 1987. With increased demand gas well drilling showed some improvement in 1988 and 1989. Gas well completions moved up to 8,734 in 1988 and are projected to be up slightly in 1989. Gas well drilling had been depressed due to a combination of low demand and low prices. Low demand had a particularly large impact on the economics of gas well drilling. Because of low demand, and a gas surplus, some gas wells had to be shut in. There was no guaranteed market for gas and this sharply reduced the incentive for drilling. This environment is changing along with the increased consumption of natural gas.

With high production rates and little new development U.S. natural gas reserves fell between 1973 and 1979. Natural gas reserves fell sharply from 249,950 billion cu.ft. in 1973 to 194,917 billion cu.ft. in 1979, down 22%. The reserves-production rate fell from 11.04 years in 1973 to 9.52 years in 1979.

However, with the increased exploration and drilling activity, reserves were sustained and actually increased slightly between 1979 and 1984. However, with the decline in drilling, reserves began to fall again, dropping to 187,211 billion cu.ft. in 1987. But because of the low level of production, the reserves production ratio was 10.79 years. Reserves fell only marginally in 1988 to 187,200 billion cu.ft. The reserves to production ratio slipped to 10.73 years. The drop in reserves in recent years may have a significant impact on future deliverability, and therefore may signal the elimination of the gas bubble.

There has been some concern expressed about the impact of natural gas imports on domestic production, and imports have been moving up rapidly in recent years. From 1973 through 1985, annual natural gas imports ranged from 904 billion cu.ft. to 1,253 billion cu.ft. As a percentage of total supply they ranged from 4.1% in 1974 and 1981 to 5.5% in 1979. The average was 4.5% of total supply. Imports fell to 750 billion cu.ft. in 1986, only 4% of total supply. This was the lowest level of imports since 1969. But when demand rebounded in 1987 imports jumped up to 992 billion cu.ft., 5.1% of supply. Imports continued to move up in 1988 to 1,283 billion cu.ft., 6.4% of total supply. Almost all of the imports are from Canada. As demand has been on the rise in recent years, Canada has been increasing its gas export capacity.

In the past, import prices were higher than domestic prices. Therefore, there was no great incentive to increase import volumes. Imports filled a small gap between domestic production and consumption and were concentrated in certain regional areas. However, recently Canada has adjusted prices to be more competitive in the U.S. market. And it is investing in capacity to increase exports to the U.S., particularly into the growing Northeastern market.

Natural Gas Liquids (NGL) production fell along with natural gas during the years of decline, but not at the same rate. Marketed production of natural gas in 1985 was down 24.1% from 1973. However, NGL production in 1985 was 1.609 million b/d, down only 7.4% from 1973. Natural gas production fell another 2.4% in 1986 and NGL production fell 3.6%. In 1987, natural gas production moved up 2.2%. NGL output was up 2.8%. Natural gas production increased 0.6% in 1988 and NGL production moved up 1.9%, to 1.625 million b/d.

Over the 1973–1985 period the NGL extraction rate had been on the rise. The quantity of gas processed fell 32%, but the extraction rate improved substantially. The volume of natural gas liquids recovered per mcf has increased from 1.353 gallons in 1973 to an estimated 1.814 gallons in 1983. This is an increase of 34.1% in the liquid extraction level. The level of extraction is tied to the relative value of the liquids versus the value of the natural gas with a higher liquids content. The extraction rate is still higher than in the 1970's, but it has slipped in recent years. It was down to 1.622 gallons per mcf in 1987 and 1.629 gallons per mcf in 1988.

OUTLOOK

There is presently a great deal of optimism about the future of the U.S. natural gas industry. The optimism seems to revolve around some of the inherent advantages of natural gas as a fuel. And there is optimism that there is a substantial domestic resource base to support an increase in future consumption. But there are only small signs of growth in industry activity. And it may take a while before this optimism is translated into fact.

In recent years the natural gas industry has found itself in the role of "swing fuel source" in a very competitive energy market. Structural problems prevented the industry from rapidly adjusting to rapidly changing competitive conditions and this made it difficult for natural gas to respond to the rapid price changes in the energy industry. The structure of the industry with government price, production and consumption regulations and with cumbersome contract problems made it less responsive to market changes.

However, the industry has made changes, and it appears that it is turning around. The contract problems are being resolved and streamlined. The industry structure is changing to meet new market conditions. The natural gas industry is beginning to become more aggressive in marketing, and this will help it to sustain existing markets and to expand into new markets. The burdensome morass of government regulations is being reduced and/or eliminated; although there is still a lot that could be done to reduce the government interference and increase the efficiency of the industry. And of great importance, pricing has become much more flexible and responsive to competing market forces.

Over the forecast period natural gas is expected to face a great deal of competition from competing fuels. The drop in crude oil prices has substantially increased the competition from distillate and residual fuel oil. Coal already has a price advantage in many areas and is expected to sustain it during the forecast period. It is estimated that more than 40% of the gas market, possibly 6 to 8 trillion cu. ft., are in the swing market. This is a market with the ability to switch to other energy sources.

But at the new lower price level, gas will be able to effectively compete in the energy market. In this era of environmental concern, it has a natural advantage as a very clean burning, non-polluting fuel source. An additional advantage is the fact that there appears to be a substantial supply available. The domestic reserve base may prove to be larger than estimated, particularly if an increase in prices stimulates additional exploration. And there are substantial additional North American supplies available, particularly from Canada. This greatly reduces supply vulnerability.

Demand for natural gas is forecast to increase 5.9% over the forecast period, moving up to 19.245 tcf in 1994. Increased economic activity and increased energy demand will stimulate demand for natural gas. Environmental concerns with coal and heavy fuel oil may also give a boost to natural gas demand.

During the initial years, growth will be relatively slow due to the intense competition from other fuels. Substantial growth is expected in demand for coal. Nuclear capacity will continue to increase during the early part of the forecast period.

Over the latter part of the forecast period growth in economic activity and energy demand is expected to continue. But growth in other competing energy sources is expected to slow. A widening gap for natural gas may develop.

Repeal of the Fuel Use Act has enabled natural gas to compete more effectively in the utility and heavy industry markets. So if and when growth in competing fuels begins to slow, consumers will turn to natural gas. Growth during the last two years of the forecast period will average about 290 bcf per year, compared to only 143 bcf during the first two years.

The real key to an increase in natural gas demand is a competitive price level. Natural gas prices are projected to have hit bottom over the 1987–1990 period, with an average wellhead price of $1.695/mcf. The price was $1.67/mcf in 1987, moved up to $1.71/mcf in 1988, and then slipped to an estimated $1.70/mcf in 1989. It is expected to remain at about that level in 1990. But prices are expected to increase gradually over the remainder of the forecast period as other energy costs rise and as the deliverability surplus is eliminated. The increase in price will be about the same as for crude oil, and this will prevent deterioration of the competitive position of natural gas. The wellhead price will move up 35.3% to $2.30/mcf in 1994. The wellhead price of crude oil is expected to increase 35.3% over the same period. The price advantage over heavy fuel oil will be maintained and gas will not lose market share to petroleum. And if there are environmental problems with the other fuels, new markets will open up to natural gas. The decline in the deliverability surplus and increased demand will also reduce gas to gas competition. And this will eliminate some of the downward pressure on prices.

With increased demand in the U.S., imports are expected to move up over the forecast period. Almost all of the imports will be from Canada. There may be a minor volume of LNG imports from Algeria and Indonesia over the forecast period. Basic demand in the U.S. is moving up and some new markets are opening up in the Northeast. The Canadians are expanding their pipeline system and production capacity to meet this new demand. Imports are projected to increase 24.1% to 1,650 billion cubic feet in 1994. One of the keys to the level of imports is the relative price of domestic vs. imported natural gas. Another key is the available pipeline capacity to service the expanding markets.

The deliverability surplus should continue to erode over the forecast period and be virtually eliminated within a couple of years. The increase in demand is expected to exceed any increase in deliverability. Additional exploration and drilling activity should increase actual total deliverability in the future. But although drilling activity will increase over the forecast period, it is not expected to be sufficient to maintain a large deliverability surplus. Rather, it is expected that deliverability will remain somewhat in balance with demand.

If some of the rigidities associated with government regulations are removed, the industry could come closer to reaching its full potential. The development of the spot market for natural gas and the increase in contract carriage are already making the natural gas industry more flexible and competitive. This will help natural gas retain its market share in the early years of the forecast period. And it will help to gain some market share in the latter years as energy demand grows and new gas markets develop.

Natural gas liquids production is projected to increase slightly over the forecast period. Production will increase 6.2% to 1.725 million b/d in 1994. Demand and prices are expected to increase sufficiently to justify an increase in gas processing and increased liquids extraction.

THE OUTLOOK—NATURAL GAS

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
NATURAL GAS VOLUMES (billion cubic feet)									
Marketed production	17,449	17,640	17,680	17,785	17,915	18,175	18,395	+755	+ 4.3
Imports	1,283	1,330	1,400	1,470	1,550	1,600	1,650	+320	+24.1
Demand	17,933	18,170	18,280	18,455	18,665	18,975	19,245	+1,075	+ 5.9
SECTOR NATURAL GAS DEMAND (billion cubic feet)									
Residential	4,630	4,650	4,675	4,680	4,690	4,695	4,700	+50	+ 1.1
Commercial	2,644	2,660	2,680	2,690	2,710	2,725	2,745	+85	+ 3.2
Industrial	6,325	6,510	6,515	6,550	6,605	6,625	6,675	+165	+ 2.5
Electric utilities	2,635	2,650	2,700	2,815	2,930	3,190	3,375	+725	+27.4
Pipeline & plant fuel	1,699	1,700	1,710	1,720	1,730	1,740	1,750	+50	+ 2.9
Total demand	**17,933**	**18,170**	**18,280**	**18,455**	**18,665**	**18,975**	**19,245**	**+1,075**	**+ 5.9**
PRICES									
U.S. wellhead price ($ per thousand cubic feet)	1.71	1.70	1.70	1.80	2.00	2.15	2.30	+ 0.60	+ 35.3
Residential price ($ per thousand cubic feet)	5.49	5.65	5.70	6.00	6.60	7.10	7.60	+1.95	+ 34.5

NATURAL GAS—KEYS TO THE FUTURE

1. The natural gas industry will shed more of the rigidity that prevented it from competing effectively in the energy market.
2. At the lower level of prices, demand for natural gas will move up throughout the forecast period.
3. Demand for natural gas will move up faster during the latter part of the forecast period. Nuclear power growth will slow, opening a gap for other fuels.
4. Natural gas prices will remain competitive, but will move up slowly. They will move up slower than crude oil prices.
5. Imports will increase, primarily due to an expanding market in the northeastern U.S.

OTHER ENERGY SOURCES

■

One of the fundamental requirements for sustaining economic activity or achieving economic growth is energy. Energy is a necessary input for all economic activity. The need for energy to fuel economic activity has not changed. However, what has changed markedly is the quantity of energy required and the source for the energy.

Energy growth and economic growth moved up at about the same rate for an extended period. All through the economic growth years of the 1950's and 1960's, energy growth and economic growth moved up at the same rate. During that period energy was inexpensive relative to other costs, and therefore was consumed only with concern for increased production. There was little concern for energy conservation. But that relationship between economic growth and energy growth changed markedly, when the price of oil and other energy increased rapidly in the 1970's. With the cost of energy moving up rapidly and having a major impact on production costs, a great deal more thought was given to energy conservation and minimizing the cost of energy.

In addition to the changing relationship between economic growth and energy, there has been a marked shift in the relative share of energy coming from major energy types. In recent years, oil and natural gas have been losing market share to other basic energy sources: coal, nuclear, hydro, geothermal and others. In general, the other forms of energy are lower cost sources of energy and are therefore preferable, if there are no operational problems associated with their use.

Oil and natural gas are sill the dominant energy sources and, when combined, supply almost two-thirds of the U.S. energy needs. But they do not satisfy all energy needs. Petroleum and natural gas are in fact, to a large extent the "swing" fuels, satisfying energy needs not met by other fuels. This is particularly true with respect to energy for electrical generation and for heavy industry. Those sectors of the economy look to natural gas and petroleum only when there is insufficient energy available from cheaper fuel sources, such as coal, hydroelectric and nuclear. This has been particularly true since the 1970's, when the price of petroleum skyrocketed, and natural gas prices soon followed.

Petroleum does have its secure niche as a liquid fuel for transportation, a role that does not appear to be threatened by fuel switching. Most long-range forecasts do not see any immediate major economic alternative for petroleum, as a transport fuel. But even in this sector of economic activity some alternatives have been introduced. Automobiles and small trucks have been converted to use propane, and there is continuous experimentation with electric cars for short-range city transport.

Natural gas is capturing a substantial part of the home heating

ELECTRICITY GENERATION AND FUEL CONSUMPTION

	Total electricity generated (Billion kwh)	Fuels consumed						
		Coal (1,000 st)	% of total	Petroleum (1,000 bbl)	% of total	Natural gas (Bcf)	% of total	Nuclear, hydro & other % of total
1975...	1,917.6	405,962	44.5	506,128	15.1	3,157.7	15.6	24.8
1976...	2,037.7	448,371	46.4	555,920	15.7	3,080.9	14.4	23.5
1977...	2,124.3	477,126	46.4	623,705	16.9	3,191.2	14.4	22.3
1978...	2,206.3	481,235	44.2	635,839	16.6	3,188.4	13.8	25.4
1979...	2,247.4	527,051	47.8	523,297	13.5	3,490.5	14.7	24.0
1980...	2,286.4	569,274	50.8	420,214	10.8	3,681.6	15.1	23.3
1981...	2,294.8	596,797	52.4	351,111	9.0	3,640.2	15.1	23.5
1982...	2,241.2	593,666	53.2	249,771	6.6	3,225.5	13.6	26.6
1983...	2,310.3	625,211	54.5	245,497	6.3	2,910.8	11.9	27.3
1984...	2,416.3	664,399	55.5	204,479	5.0	3,111.3	12.3	27.2
1985...	2,469.8	693,841	56.8	173,414	4.1	3,044.1	11.8	27.3
1986...	2,487.3	685,056	55.7	230,482	5.5	2,602.4	10.0	28.8
1987...	2,572.1	717,894	56.9	199,378	4.6	2,844.1	10.6	27.9
1988...	2,701.6	757,522	56.9	247,768	5.5	2,634.8	9.4	28.2

Source: Energy Information Administration

COAL PRODUCTION

	Production	Consumption	Imports	Exports
	(1,000 short tons)			
1975	654,641	562,640	940	66,309
1976	684,913	603,790	1,203	60,021
1977	697,205	625,291	1,647	54,312
1978	670,164	625,225	2,953	40,714
1979	781,134	680,524	2,059	56,042
1980	829,700	702,729	1,194	91,742
1981	823,775	732,628	1,043	112,541
1982	838,111	706,910	742	106,277
1983	782,091	736,671	1,271	77,772
1984	895,921	791,291	1,286	81,483
1985	883,638	818,049	1,952	92,680
1986	890,315	804,312	2,212	85,518
1987	918,762	836,941	1,747	79,607
1988	949,761	882,815	2,134	95,023
% chg. 88/75	+45.1	+56.9	+127.0	+43.3

Source: Energy Information Administration

NUCLEAR POWER PLANT OPERATIONS

	Number of reactors	Electricity generated (Million net kwh)	% of total electricity generated	Net summer capability (Million net kw)	Capacity utilized (%)
1975	54	172,505	9.0	37.161	56.0
1976	61	191,104	9.4	43.657	54.9
1977	65	250,883	11.8	46.202	63.4
1978	70	276,403	12.5	50.709	64.7
1979	68	255,155	11.4	49.630	58.5
1980	70	251,116	11.0	51.668	56.4
1981	74	272,674	11.9	55.914	58.4
1982	77	282,773	12.6	59.927	56.7
1363	80	293,677	12.7	63.009	54.4
1984	86	327,634	13.6	69.652	56.3
1985	95	383,691	15.5	79.397	58.0
1986	100	414,038	16.6	85.241	56.9
1987	107	455,270	17.7	93.583	57.5
1988	108	526,901	19.5	95.089	63.5
% chg 88/75	+100.0	+205.4	–	+155.9	–

Source: Energy Information Administration

market. It has a definite advantage as a clean burning, efficient, and relatively low cost fuel. Natural gas also has an established market in the industrial and utility sectors, provided it remains price competitive. Its advantage as a clean burning, non-polluting fuel could translate into increased demand in the future. This is particularly true if environmental concerns about acid rain and clean air remain important political and environmental objectives. Given the current mood it is almost a certainty that these and other environmental issues will be of primary concern over the forecast period.

At the low oil prices that occurred in 1986, all of the three major fuel sources, petroleum, natural gas and coal, were competing in the industrial market. It is likely that the future will see more competition between fuels due to the increased multi-fuel capacity of major consumers. With that sharp drop in energy prices in 1986, the economics of energy may have shifted again.

Crude oil prices moved up again in 1987, but did not reach a level anywhere close to the level of the 1979–1985 period. But then prices fell again in 1988 due to over production by the OPEC group of countries. In 1989 prices returned to a level close to 1987, as demand moved up to match output. Oil prices appear to be going through a period of sharp cyclical changes influenced by OPEC production decisions. Natural gas prices moved down in 1987, 1988, and 1989, in order to keep natural gas price competitive with other fuels.

Lower energy prices tend to slow the conservation effort. And the lower cost of petroleum and natural gas markedly changes the economics of investing in capital equipment for conversion to other fuels. The lower cost of energy lengthens the pay-back period on the increased capital investment required for new capital equipment. In many cases conversion has become uneconomical.

What happens with respect to these other forms of energy has a major impact on the future for crude oil and natural gas. This section will review the recent trends in other energy sources. And a projection will be presented of expectations for these other forms of energy during the 1989–1994 forecast period.

REVIEW

TRENDS IN OTHER TYPES OF ENERGY. Over the past 10–15 years the energy industry has gone through several major transitions and a number of shifts in direction. One of the factors causing the transition has been the rapid and massive changes in the price of energy, large movements both up and down. The other factor having a major impact on energy requirements is the gradual shift of the economy to a more service-oriented, less industrial economy. These two factors have greatly influenced the quantity and type of energy consumed.

Energy prices started to move up in the 1970's, following a long period of relatively low cost energy. The increase was led by petroleum prices which first moved up in 1973–1974, and then rapidly increased from 1979–1981. Natural gas prices followed and also started accelerating upward in the late 1970's and early 1980's. Coal and electric power prices also followed along.

Therefore, all energy rapidly became more expensive during this time period. This increase in prices for basic energy made it very attractive for energy users to find ways to conserve on the level of energy consumption. When competing energy prices were out of balance, it also became cost effective to switch, if possible, to other energy forms. Therefore, it became economically attractive to invest in capital equipment that would reduce energy consumption. And it became cost effective to invest in equipment to establish multi-fuel capability so that large fuel users could select the least costly fuel.

Over the same period the economy was in a transition to a more service oriented and automated economy. This newly evolving economy is less energy intensive than an economy dominated by heavy industry. In addition, there is an accompanying shift toward more electrical power consumption in the modern economy. All of these shifts had an impact on the quantity and type of fuel that was consumed.

Conservation led to a drop in energy consumption per unit of economic activity. Energy consumption per unit of GNP had been falling continuously since 1970. But the increase in prices accelerated the reduction. Energy consumed per unit of GNP has fallen 28.8% between 1970 and 1989 and is still falling. With a sharp increase in energy consumption the improvement in efficiency slowed from 1986–1988. But it appears to have resumed again.

The total amount of energy consumed peaked in 1979 at 78,898 trillion BTU. It fell 10.7% to 70,497 trillion BTU in 1983. It was then oscillating up and down for a few years. It moved up to 74,101 trillion BTU in 1984, down to 73,945 trillion BTU in 1985 and then back up to 74,237 trillion BTU in 1986. Energy consumption has been climbing since 1985. It moved up to 76,763 trillion BTU in 1987, and 80,135 trillion BTU in 1988. It is estimated at 81,425 trillion BTU in 1989. It is up 10.1% since 1985.

Between 1979 and 1988 GNP increased 26.1%, while total energy consumed to fuel the increased economic activity moved up only 1.6%. This is in sharp contrast to the earlier era 1950–1970. Over that span, GNP moved up 100.2% and energy consumption increased 97.5%. At that time there was a one to one relationship between economic growth and energy growth. This changed markedly with higher energy costs.

There was a substantial shift in energy market shares for the various fuels between the year of peak energy consumption, 1979, and 1985. Petroleum's share of the energy market fell from 47.1% in 1979 to 41.8% in 1985. The share from natural gas fell from 26.2% to 24.1%. The lost market share was taken by coal, nuclear and hydroelectric and geothermal energy. Coal energy moved up from 19.1% to 23.6% of the market in 1985. Hydroelectric and geothermal moved up from 4.1% to 4.9%, and nuclear power increased from 3.5% to 5.6% of the energy market.

Due to the sharp drop in crude oil prices in 1986 there was a temporary shift in the trend of market shares. Petroleum's share moved up to 43.4%, coal fell to 23.2%, natural gas fell to 22.5%, nuclear moved up to 6.1%, and hydro and others slipped to 4.8%.

Higher crude oil prices changed the competitive mix again in 1987. In 1987 petroleum dropped slightly to 42.8%. Natural gas moved up to 23%, coal moved up to 23.5%, nuclear moved up again to 6.4% and hydro fell to 4.3%. Although petroleum prices fell again in 1988 market share slipped to 42.7%. Natural gas moved up to 23.1% of the market. Coal stayed at 23.5%, but nuclear jumped to 7.1% of total energy. Due to poor weather conditions hydroelectric and other energy fell to only 3.6%.

Total energy consumption is estimated at 81,425 trillion BTU for 1989, up 1.6%. And the energy mix is expected to change again. Petroleum will remain at 42.7% of the market while natural gas falls to 23%. Hydroelectric, geothermal and other miscellaneous energy are expected to recapture a share of the market moving up to 3.9%. As a result coal will slip to 23.4%. Nuclear will fall to 7%. Some shut downs for maintenance slowed the growth in nuclear energy in 1989.

ELECTRICAL ENERGY. The growth in consumption of electrical power has been one of the most consistent and long term trends in the energy industry. In addition the portion of total energy used for generating electrical power has been steadily increasing.

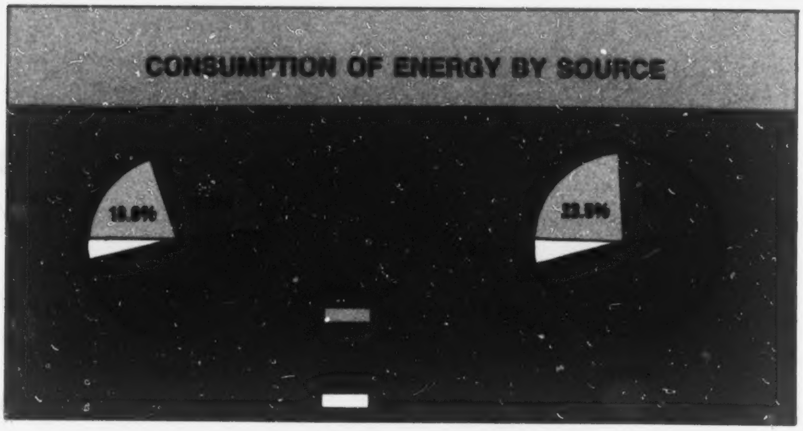
In 1947, just after World War II, only 12.9% of total U.S. energy consumption went for generation of electrical power. As the economy grew and changed this changed substantially. By 1961 it had climbed to 18.8%, and by 1971 it was up to 25.2% and still climbing. It reached 33.5% in 1981 and was 35.9 in 1987 and 35.8% in 1988. Over one-third of all energy consumed is now used for electric power generation. And the percentage will be increasing as the economy changes and grows.

This upward trend to a higher percentage of energy for electrical power will continue for the foreseeable future. The economy is shifting to more service and information oriented activity and industry is shifting toward more automation. Both of these movements call for energy in the form of electricity.

Net electricity generation at electric utilities has moved up in every year but one since 1973. Net electricity generated in 1973 was 1,860.7 billion kilowatt hours. This increased 45.2% to 2,701.6 billion kilowatt hours in 1988. This translates to an average annual growth rate of 2.52% per year over fifteen years.

Demand for electricity has gone up in all sectors of the economy. Growth has been greatest in the commercial sector, reflecting the shift to a service economy. Commercial demand has increased 82.9% from 1973–1988. Residential demand has increased 53.6% and industrial demand has moved up 28.9%. Electrical energy is produced using all of the basic forms of energy: petroleum, natural gas, coal, hydro, nuclear, geothermal and others.

Coal has been and continues to be the primary fuel source for electrical utilities. In 1973 coal accounted for 43.6% of the fuel for electric power generation. This moved up to 54.6% in 1985. Coal lost a portion of its utility market share in 1986, due to the extremely low oil prices, and fell slightly to 54.2%. With the increase in oil



ELECTRIC SECTOR: RELATION TO TOTAL PRODUCT DEMAND

	Total coal consumption — (1,000 short tons) —	Coal consumed in electric generation	%	Total petroleum consumption —— (1,000 b/d) ——	Petroleum consumed in electric generation	%	Total natural gas consumption —— (Bcf) ——	Natural gas consumed in electric generation	%
1973..	562,584	389,212	69.2	17,308	1,535	8.9	22,049	3,660.2	16.6
1979..	680,524	527,051	77.4	18,513	1,433	7.7	20,241	3,490.5	17.2
1987..	836,941	717,894	85.8	16,665	546	3.3	17,137	2,844.1	16.6
1988..	882,815	757,522	85.8	17,283	677	3.9	17,933	2,634.8	14.7

Source: Energy Information Administration

ELECTRICITY SALES

	Residential	Commercial	Industrial (Million kwh)	Other	Total
1975	588,140	403,049	687,680	68,222	1,747,091
1976	606,452	425,094	754,069	69,631	1,855,246
1977	645,239	446,514	786,037	70,571	1,948,361
1978	674,466	461,163	809,078	73,215	2,017,922
1979	682,819	473,307	841,903	73,070	2,071,099
1980	717,495	488,155	815,067	73,732	2,094,449
1981	722,265	514,338	825,743	84,756	2,147,103
1982	729,520	526,397	744,949	85,575	2,086,441
1983	750,948	543,788	775,999	80,219	2,150,955
1984	777,654	578,281	840,588	81,849	2,278,372
1985	790,977	608,968	824,523	85,075	2,309,543
1986	817,663	641,469	808,292	83,409	2,350,835
1987	849,613	673,707	845,266	86,854	2,455,440
1988	889,860	710,204	884,026	82,108	2,566,198
% chg 88/75	+51.3	+76.2	+28.6	+20.4	+46.9

Source: Energy Information Administration

prices in 1987, coal moved back up to 55% of the energy for electric utilities. It moved up again to 55.3% in 1988.

The level of total coal consumption is mostly dependent upon electric utility demand. Therefore, coal consumption has been rising rather steadily over this period of fluctuating energy demand. Coal consumption moved up from 562.6 million short tons in 1973 to 818 million in 1985, an increase of 45.4%. Consumption declined slightly in 1986, falling to 804.3 million short tons, down 1.7%. It rebounded in 1987 increasing 4.1% to 836.9 million short tons. With strong electricity demand it increased 5.5% in 1988 to 882.8 million short tons.

Coal consumption levels vary with economic activity, but increased consumption by electric utilities has continued to push up demand. Coal consumed by electric utilities increased 783%, from 389.2 million short tons in 1973 to 693.8 million short tons in 1985. The percentage of total coal consumed in electric power generation increased from 69.2% in 1973 to 84.8% in 1985. Over this period, coal consumed by utilities moved up 305 million short tons, while total coal consumption moved up only 255 million short tons. The long-run growth in coal consumption is obviously dependent upon the growth in electrical power generation.

However, coal does face some potential competition, even in electric power generation. When oil prices dropped to extremely low levels during mid 1986, coal lost some of its utility market to petroleum. As a result, in 1986 coal consumption by electric utilities fell 8.8 million short tons to 685.1 million short tons. Total coal consumption fell 13.7 million short tons. Coal consumption by industrial coke plants also fell in 1986, dropping 5.1 million short tons.

Oil prices moved back up in 1987, reducing some of the competitive pressure. Coal consumption by electric utilities increased 4.8% to 717.9 million short tons. This was an increase of 32.8 million short tons. Total coal consumption moved up 32.6 million short tons. Even though oil prices fell again in 1988, coal consumption moved up on the strength of electric utility demand. Coal consumed by electric utilities increased 5.5% in 1988, increasing 39.6 million short tons to 757.5 million short tons.

Nuclear power's share of total electrical power generation has also been rising steadily. The nuclear power share of total energy used for electrical generation increased from 4.6% in 1973 to 19.8% in 1988.

The number of operable nuclear reactors increased from 39 at year-end 1973 to 108 at the end of 1988 and up to 110 by mid-year 1989. The peak capacity defined as "net summer capacity of operable reactors" moved up from 22.615 million net kilowatts in 1973 to 95.089 million at year end 1988, and 97.188 million net kilowatts in mid-1989. Electricity generated increased from 83.5 billion net kilowatt-hours in 1973 to 527 billion net kilowatt- hours in 1988, an increase of 531.2% in electrical power generated.

Although the power generated by nuclear facilities has steadily increased along with the capacity, the utilization rate of the reactors has fluctuated. The percentage of capacity utilized has fluctuated from a low of 47.9% in 1974 to a high of 64.7% in 1978.

After the Three Mile Island incident the utilization rate decreased. Concerns for safety increased the amount of time the reactors were shut down for maintenance and safety checks. The rate fell to 54.4% in 1983. It was 56.3% in 1984, 58% in 1985 and 56.9% in 1986. It moved up to 57.4% in 1987, and 63.5% in 1988. The utilization rate is expected to be down sharply in 1989, since a number of units were undergoing maintenance.

However, it is felt that there is considerable room for improvement in the utilization rate. Additional power could be generated without new facilities if the utilization rate was increased. This would be a major factor in the future growth of nuclear power. Only a few new units are to be completed in the future.

Hydroelectric power supplied only 9.1% of energy for electric power generation in 1988. Hydroelectric power energy output dropped to 2,612 trillion BTU, the lowest level in years. The hydro share depends upon weather conditions such as rainfall and snowfall in certain regional areas. The rainfall and snow melt were very low in 1987 and 1988. Hydropower hit a peak in 1983 at 3,866 trillion BTU. This was 15.5% of the energy for electric power that year.

The natural gas share of energy consumed for electrical power generation fell from 18.9% in 1973 to 10.1% in 1986. It moved up slightly to 10.7% as it recaptured market share from petroleum in 1987. But it fell again in 1988 dropping to 9.5%. Total natural gas energy consumed for electric power generation was 3,748 trillion BTU in 1973. It was down to 2,719 trillion BTU in 1988.

The volume of gas consumed by electric utilities fell 29%, from 3,660 billion cubic feet in 1973 to 2,602 billion cubic feet in 1986. This decline accounted for 17.5% of the overall drop in natural gas consumption from 1973–1986. There was a loss of 442 billion cubic feet in 1986 as natural gas lost market share in the utility sector to low cost heavy fuel oil. The volume moved up to 2,844 billion cubic feet in 1987. Gas prices were more competitive with crude oil prices and gas regained a portion of the utility market. However, consumption in this area fell again in 1988 to 2,635 billion cubic feet. Low heavy fuel oil prices enabled oil to displace some natural gas as it had in 1986.

The share of total natural gas consumed by electric utilities was 16.6% in 1973. It moved up to 18.8% in 1981. At that time, there were concerns about natural gas shortages developing in other sectors of the economy and government restrictions were placed on natural gas use by utilities. The share fell to 17.3% in 1983, and down to a low 16.0% in 1986. In 1986 competitive pressure from extremely low cost heavy oil reduced the volume of natural gas consumed by electric utilities. It jumped back up to 17.1% in 1987 when crude oil prices moved higher and gas regained its competitive advantage. The share of gas used for power generation fell sharply in 1988 to 14.7%. Power plants switched to lower cost heavy fuel oil again in 1988.

The largest drop in natural gas consumption was in the industrial sector. Industrial natural gas consumption fell 35.8% from 8,689 billion cubic feet in 1973 to 5,579 billion cubic feet in 1986. This was a drop of 3,110 billion cubic feet. It accounted for 53.3% of the decline in natural gas consumption between 1973 and 1986. Conservation, fuel switching and an economic shift away from heavy industry all contributed to the decline.

With somewhat of a resurgence of industrial activity consumption of natural gas in the industrial sector moved up in 1987 increasing 316 billion cubic feet, 5.7%. Lower prices for natural gas, higher prices for heavy fuel oil, and more aggressive gas marketing accounted for the increase. The upward swing in gas consumption in industrial activity continued in 1988, moving up another 7.3%, 430 billion cubic feet, to 6,325 billion cubic feet.

The petroleum energy share of energy used for electric power generation fell from 17.7% in 1973 to 4.1% in 1985. Substantially lower heavy fuel oil prices in 1986 stimulated electric utility consumption of petroleum. The petroleum share moved up to 5.5% in 1986 as the energy input from petroleum increased 33.2%. In 1986 the price of heavy residual fuel oil fell to a level that was competitive with natural gas and even coal in electrical power generation. The electrical utilities with multi-fuel capability shifted to residual fuel consumption to take advantage of the lower cost.

With higher fuel oil prices in 1987 the share of electric power from petroleum fell to 4.6%. But lower prices in 1988 boosted the share back up to 5.4%.

The volume of oil consumed in electric power generation fell 69% from 560 million barrels in 1973 to 173 million barrels in 1985. It rebounded to 230 million barrels in 1986 due to lower oil prices. Consumption slipped back in 1987 to 199 million barrels as oil prices rebounded. But prices plummeted again in 1988 and oil consumption by electric utilities jumped up to 248 million barrels.

The drop in petroleum used for power generation is the major reason for the decline in heavy residual fuel oil consumption. The share of total petroleum consumption used for electrical power generation fell from 8.9% in 1973 to 3.0% in 1985. It moved up to 3.9% in 1986, but slipped to 3.3% in 1987. In bounced back to 3.9% in 1988 as utility consumption of petroleum increased sharply.

As the economy continues to shift toward services and automation, electrical power demand is expected to continue to increase. The energy sources that provides the fuel for power generation will also continue to grow over the forecast period.

OUTLOOK

U.S. economic activity is projected to continue to grow throughout the forecast period, but at a slow pace. It is expected that 1991 may be a year of rather low growth due to concerns with the government deficit and the trade imbalance. The average annual growth rate is forecast at 2.7%–3% for the five years 1989–1994. Real GNP is expected to be up 14%–15% by 1994.

Efforts aimed toward energy conservation are expected to continue. And the economy is expected to continue its shift toward industries that are less energy intensive—a movement toward the service and information industries and away from energy intensive heavy manufacturing industries. The result will be a continued improvement in energy efficiency over the forecast period. The energy consumed per real GNP dollar is expected to decline another 5% to 6% by 1994. By the end of the forecast period 33% less energy will be required per dollar of real GNP than in 1970.

Consumption of all forms of basic energy is expected to increase over the forecast period. The relative amounts of each type of energy consumed will be influenced a great deal by the increase in electrical power demand.

The shift toward a more service-oriented and automated economy will boost demand for electrical power. Electrical power consumption is projected to increase much faster than total energy. Electrical power generation is projected to increase 15.9% by 1994, to 3210 billion kilowatt hours. Total energy consumption is projected to increase only 8.2%.

The growth in electrical power generation will be fueled mainly by growth in hydropower, nuclear energy, and coal. The hydro and nuclear share of electrical energy and of total energy will be on the increase over the forecast period.

Nuclear power generation is projected to lead the way in additional electrical power output during the early part of the forecast period. But it is expected to hit a peak in 1993 and remain at that level. No new nuclear plants are being planned. Therefore, when existing construction is completed, major growth in nuclear power will come to a halt. Electrical power generation from nuclear plants is expected to increase 9.2% over the forecast period. Nuclear plant capacity will not be increased after 1993, but there could be increased energy from an improvement in the utilization rate of nuclear capacity. Nuclear power will contribute 7.0% of all energy in 1994, little change from the share in 1989. The nuclear share of total energy will peak in 1992 at 7.2%.

The extent of growth in nuclear power generation beyond the forecast period is in doubt. Long range growth of nuclear power has become more of a political and environmental issue than an economic decision. Concerns about the safety of nuclear facilities has almost halted the growth in nuclear capacity beyond the forecast period. With lead times of ten years or more for planning and construction of new facilities, increased capacity can not be expected in the foreseeable future.

However, additional output may be obtained if plant efficiency improves and the utilization rate of existing facilities moves up.

With an expected increase in electrical power demand, coal consumption will also increase over the 1989-1994 period. Coal consumption will increase 7.8% over the period to 965 million short tons. Coal consumed by the electric utility industry is projected to increase to about 840 million short tons from 770 million short tons in 1989. In 1994 about 87% of all coal will be consumed by electric utilities.

The one issue that may cloud the longer range outlook for the increase in coal consumption is concern about acid rain. If environmental concerns about acid rain and clean air end up adding a lot to the cost of using coal, it could lose some of its competitive price advantage over petroleum and natural gas. In that case the growth of coal consumption would be slowed. This forecast assumes that coal will be able to maintain its competitive advantage. But this is an area of major concern and could greatly influence future trends.

Basic energy from coal will increase at about the same rate, up 8% to 20,620 trillion BTU in 1994. Coal's share of the total energy market will be 23.4% in 1994. Coal will not gain market share. A substantial portion of the growth in electrical power generation will come from nuclear and revived hydro power.

Hydro and other energy are expected to move up substantially from the present depressed levels of 1988 and 1989. Hydropower is dependent upon weather conditions. A return to more normal, wetter weather, will boost hydro output. Hydropower is projected to move up close to capacity during the forecast period.

Energy from hydro and other sources will increase about 27% over the forecast period to 4,000 trillion BTU in 1994. Its share of the energy market will increase to 4.5% from 3.9% in 1989 and only 3.6% in 1988.

Lower oil and natural gas prices could make these fuels more competitive in the electrical power generation market. However, they are not expected to make much headway until the growth in nuclear generation slows and coal consumption becomes a major environmental issue. The impact may start to show up late in the forecast period.

The growth in demand for petroleum energy is expected mainly in economic sectors where it has an advantage as a liquid transport fuel. And there will be growth in industrial sectors such as petrochemicals, where it is an important feedstock. Petroleum energy consumption is expected to increase 7.7% to 37,400 trillion BTU in 1994. Its share of the energy market will dip to 42.5% from 42.7% in 1989.

Natural gas is expected to lose market share over the forecast period. Demand for natural gas is expected to be sluggish during the first two years of the forecast period 1990 and 1991. But consumption is expected to move up more rapidly the latter part of the period 1992-1994.

Energy from natural gas is projected to increase 1.6% from 1989 to 1991. Its share of the energy market is projected to fall from 23% to 22.6% in 1991.

Over the next three years natural gas demand is expected to increase 5.7%. However, its share of the market will slip to 22.5% in 1994. A faster rate of economic growth during the latter part of the forecast period 1992-1994 will result in increased energy consumption. During this period an energy gap will develop that will be filled by increased natural gas consumption. Nuclear energy growth is expected to come to a halt in 1993. Energy from coal is also expected to be constrained due to environmental concerns. Therefore, growth of these two fuels will not be sufficient to meet the growth in total energy requirements.

It should be noted that beyond the forecast period, providing adequate electrical power to meet the growing demand for electricity may become a serious problem. The two major sources of energy for electrical power generation are coal and nuclear power. Both of these energy sources are under attack from environmental groups concerned about nuclear power dangers and potential environmental pollution. What could develop is a surge in demand for petroleum and/or natural gas for electric power generation.

THE OUTLOOK—OTHER ENERGY SOURCES

	1988	1989	1990	1991	1992	1993	1994	Change 1989 to 1994	% change 1989 to 1994
ENERGY DEMAND (trillion BTU)									
Petroleum	34,209	34,770	35,290	35,760	36,450	36,960	37,460	+2,690	+ 7.7
Natural gas	18,489	18,735	18,850	19,030	19,250	19,570	19,850	+1,115	+ 6.0
Coal	18,840	19,090	19,260	19,500	19,800	20,150	20,620	+1,530	+ 8.0
Nuclear	5,678	5,680	5,850	6,060	6,150	6,200	6,200	+520	+ 9.2
Hydro and other	2,919	3,150	3,500	3,750	3,900	3,950	4,000	+850	+27.0
Total energy demand	**80,135**	**81,425**	**82,750**	**84,100**	**85,550**	**86,830**	**88,130**	**+6,705**	**+ 8.2**
Coal consumption (million short tons)	883	895	905	915	930	945	965	+70	+ 7.8
Electricity generation (billion kilowatthours)	2,702	2,770	2,840	2,900	3,020	3,100	3,210	+440	+15.9
Nuclear capacity (million kilowatts)	95	97	99	101	102	103	103	+6	+ 6.2
Nuclear generation (billion kilowatthours)	527	525	540	560	570	575	575	+50	+ 9.5

OTHER ENERGY SOURCES—KEYS TO THE FUTURE

1. Economic activity will continue to grow throughout the forecast period. Real GNP will increase at an average annual rate of 2.7% and be up 14.6% by 1994.

2. Energy consumption will move up to fuel the economic growth. Total U.S. energy consumption will increase throughout the forecast period. Annual energy consumption will be 8.2% higher in 1994.

3. The shift toward less energy intensive industries will continue. The U.S. economy will become more service and information oriented. This will result in a growing demand for electrical power which is projected to be up 15.9% by 1994.

4. The generation of electrical energy from nuclear power will reach a peak in 1993, since no new capacity will be added. After that any growth will be due to an improvement in the rate of capacity utilization.

5. Hydropower energy will rebound and move back toward capacity. This will supply a lot of the growth in energy required for additional electric power generation.

6. Coal consumption will increase 7.8% over the forecast period. The increase will be due to the increase in electrical power demand. Coal consumption could run into some environmental problems during the forecast period.

7. There could be increased electric utility demand for natural gas and/or petroleum during the forecast period, if environmental issues restrict the growth of energy from coal and nuclear power.

OTHER FORECASTS

Developing an outlook to be used for planning, operating and investment decisions can be a difficult task. It is often quite worthwhile to review a collection of other views, opinions and forecasts. This can be a rewarding exercise. It reveals other ways that current activities and events can be interpreted and projected.

Several groups have recently made longer-range forecasts and/or studies of the U.S. and worldwide energy and oil industry. Following is a brief summary of the highlights from several of these forecasts and studies.

ENERGY INFORMATION ADMINISTRATION (EIA)

The U.S. Energy Information Administration (EIA), a part of the U. S. Department of Energy, recently came out with a couple of publications containing their long range U.S. oil and gas forecast: "Annual Outlook for Oil and Gas, 1989" and "Annual Energy Outlook 1989, with Projections to 2000." Both of these studies made projections out to the year 2000, and the projections in the two reports were almost identical.

They presented three separate scenarios based upon three separate price projections: low world oil prices, base case or middle price case, and high world oil prices. In the report the EIA points out that, "Oil prices are influenced by a number of economic, technological and political factors that may interact in unexpected ways." They use a forecasting model to present three possible price scenarios and the results of each. Under all three scenarios prices are expected to move up through the forecast period.

The EIA report makes a number of points concerning the future level of prices. With respect to OPEC, they conclude that their future influence is closely tied to the management of excess capacity. Discussing the volatile price movements over the last few years, and the relationship to OPEC production, the EIA report states, "Nevertheless, if OPEC as a whole (or a single large producer, such as Saudi Arabia) is unwilling to adjust production downward when needed to stabilize prices in the future, the old pattern threatens to repeat itself so long as excess production capacity remains. Wide fluctuations in price can recur, as OPEC tries again and again to manage its own output; and the situation may persist until the mid-1990's (when OPEC may once more be selling enough oil to approach the limit of output it is capable of producing)."

They conclude that it is likely that, "world oil prices will continue to be volatile and low for at least the next year or two." But looking longer range they conclude that, "excess production capacity around the world is bound to diminish as population expands and economic development and growth continue."

They also point out that technological changes may increasingly affect the price. "The economic forces that determine the supply and demand for oil include technological change in both the production and consumption of energy, the size of the resource base (which can also be affected by technology) and overall economic growth." They further conclude that oil prices will be influenced by the cost of developing natural gas resources. This is because competition from natural gas tends to curb oil demand.

In the base case the world price of oil (in constant 1988 dollars) moves up from $14.70/bbl in 1988 to $20.60/bbl in 1995 and $28.00/bbl in 2000. This is a price increase of 90.5% by year 2000, and average annual increase of over 5.5%/year. Over the first period, to 1995, the price moves up a bit slower, 40.1%, which is 5%/year. The rate of increase from 1995–2000 is just over 6.3%/year.

In the low price scenario world crude oil prices move up to $16.70/bbl in 1995 and $21.70/bbl in 2000. In this case prices increase only 13.6% by 1995, 1.8%/year. Through 2000 the increase is 47.6%, 3.3%/year. With the high price scenario the rate of increase is much greater. Under this case the world crude oil price jumps to $24.40/bbl in 1995 and $35.00/bbl in 2000. Prices are up 66% by 1995 and up 138.1% by 2000, an annual growth rate of 7.5%/year for the entire forecast period.

The EIA summarized their outlook concerning prices with this statement, "Erratic variations in price might be anticipated for several years, while OPEC tries once again to control the combined output of member countries with dissimilar interests. Furthermore, non-OPEC oil production is still growing slowly. By 2000 however, fundamental forces of supply and demand should raise prices (absent any dramatic technological changes), as rising consumption drains off excess capacity and the geographic concentration of reserves restores OPEC's power in the market."

According to the EIA Annual Energy Outlook report, the economic growth rate is not much different under the three price scenarios presented. The growth rate for real GNP would be 2.5%/year for the entire forecast period, under both the low and base case price scenarios. With the higher prices the economic growth rate would be 2.4%/year. Both of these growth rates are lower than the pace of U.S. economic growth since 1970. The other report used slightly different assumptions and came out with a growth rate of 2.2% with high energy prices and 2.8% with low energy prices.

The EIA projects a continuing improvement in energy efficiency over the forecast period. The trend in the ratio of energy use to economic output has been declining since 1970. In recent years the improvement in energy efficiency has moderated from the long term trend rate of 2.1%/year. But the EIA projects the ratio to decline at an average annual rate of 1.3%/year for the rest of the century.

The ratio of oil and gas use to GNP has declined more rapidly than the total energy to GNP ratio.

With respect to their projection of this ratio the EIA report says, "During the forecast period, this measure of U.S. oil and gas intensity now looks as if it could continue to decline at about 2%/year, reflecting both higher efficiency and the continued consumer preference for electricity in many sectors. At the same time, however, the rising consumption of oil and gas for electricity generation and the continued growth in demand for petrochemical products will help to slow down the future rate of decline in this ratio."

These assumptions are the basis for the EIA outlook for U.S. oil and natural gas from now to the year 2000. Following is a brief summary of the EIA projections for oil and natural gas consumption and production over the forecast period.

Under the base case price scenario they project U.S. total demand (total products supplied) for petroleum products to move up to 18.54 million b/d in 2000. This would be an increase of only 7.3% over the forecast period. A very modest average annual growth rate of 0.6%/year. The rate of increase in demand will move up during the latter part of the forecast period. Total product demand will increase 3.3% between 1988 and 1995, but it is projected to increase 3.9% between 1995 and 2000.

Demand for motor gasoline is expected to decline over the forecast period while the demand for other products will move up. Demand for motor gasoline is projected to fall to 7.18 million b/d in 1995, down 2.2%. Then it is projected to move up a little to 7.23 million b/d in 2000. During the first part of the forecast period, improvement in the fuel efficiency of the vehicle fleet is expected to more than offset the increase in the size of the fleet and in the number of miles driven. But the rate of improvement in fleet fuel efficiency is expected to decline over the forecast period. Therefore, during the latter part of the forecast period motor gasoline demand will move up due to an increase in the size of the fleet and in miles driven.

Distillate demand is forecast to increase 17.6% to 3.67 million b/d in 2000. This is an average annual rate of growth of 1.35%/year. Jet fuel demand will move up at about the same pace, increasing 17.2% to 1.7 million b/d in 2000. A good portion of the increase in distillate demand will be for transport diesel fuel. Average freight truck fuel efficiency is expected to improve 13% by 2000. But vehicle miles traveled by freight trucks is projected to grow by 32% over the same period. Jet fuel demand is expected to move up at a slower pace than it has recently. Passenger and freight air traffic are expected to increase along with economic growth. But a portion of the increase in fuel demand due to increased traffic will be offset by more fuel efficient new aircraft.

Demand for residual fuel oil is projected to increase 16.7% by the year 2000, moving up to 1.61 million b/d. A large part of the growth is expected in the latter stages of the forecast period. Over the five years from 1988–1993 demand for resid is expected to move up only 0.7%. But from 1993–2000 the growth is projected at 15.8%. Electric utility consumption of petroleum is projected to increase at 5–6%/year over the forecast period. Much of the increase is expected after 1995. According to EIA, "Greater use of petroleum results primarily because of increased demand rather than any shift in market share based on the price of oil relative to natural gas in specific regions." They conclude that the increased use of oil for power generation is "inevitable."

The EIA projects declining domestic crude production throughout the forecast period, falling 26.4%, to 5.99 million b/d in 2000. Alaskan production is forecast to fall steadily during the period, dropping to 910,000 b/d in 2000. Lower-48 production is forecast to fall to 4.76 million b/d in 1995. But rising oil prices are expected to stimulate drilling and lower-48 production is projected to increase over the last five years of the forecast period to 5.08 million b/d.

With increasing demand and declining domestic production imports of crude oil and petroleum products are projected to increase 46.5%, to 10.84 million b/d in 2000. Net imports (i.e., imports minus exports) are forecast to increase 52% to 10.02 million b/d in 2000. Net imports as a percentage of domestic demand is projected to move up from 38.1% in 1988 to 54% in 2000.

The EIA report also projects growth in the natural gas industry over the forecast period. However, the report does state, "Projections of the future course of the natural gas market depend critically on the likely effects of decreasing regulation of the natural gas industry and to a large extent on the direction of the electric power industry."

Some of the key assumptions behind the gas industry forecast are:

"The price of gas to end users is projected to compete favorably with alternative fuels.

Sustained growth of gas use by electric utilities is projected, particularly in the mid to late 1990's, as a significant shift to gas use in combined cycle systems is expected.

Adequate, competitively priced supplies are projected to be available."

Consumption of natural gas is forecast to increase 13.4% by 2000, to 20.45 tcf. The growth rate will accelerate toward the end of the forecast period. Almost all of the growth will be in the electric utility sector.

Domestic production of natural gas will move up 11.7% to 18.58 tcf in 2000. Imports will almost double, increasing 94.9% to 2.3 tcf.

The average wellhead price of natural gas will increase 128.1% to $3.90/mcf in 2000. The average delivered price will increase 50.3% to $5.77/mcf.

ASHLAND OIL, INC.

Chief Economist and Director of Market Research at Ashland Oil, Inc., Dr. Cyrus Hussein Tahmassebi, presented a paper titled "The Outlook For World Oil Markets, 1990-2000." In this paper, Dr. Tahmassebi presented his worldwide projections of supply and demand through the year 2000.

Three price scenarios were given in the paper. The Base-Line scenario projected the current dollar price for crude oil moving up from $13.32/bbl in 1988, to $1/bbl in 1990, $22/bbl in 1995 and $30/bbl in 2000. The price used was the spot price for Arab Light crude. The average annual rate of increase was 8.0% between 1988 and 1995 and 6.4% between 1995 and 2000.

The real price in 1988 dollars was forecast to move up at an annual rate of 2.7% per year from 1988–1995, and drop to 0.9% per year from 1995–2000.

Total free world demand for energy was forecast to move up 3.8% from 1988 to 1990. It is then expected to increase 9.91% from 1990 to 1995, and 7.8% from 1995–2000. The growth from 1988-2000 is projected at 22.9%.

Coal demand is projected to increase 28.4% from 1988–2000. Coal's market share would move up from 21.6% to 22.6%. Natural gas demand was projected to increase 42.1% and the market share increase from 17.7% to 20.5%. Oil demand is expected to increase only 8.8%. And it will lose market share, falling from 46.7% to 41.4%. Nuclear power will move up 42%, and reach a market share of 7.4% in 2000. Energy from hydro and other sources will increase 33.8% by the year 2000.

The base case projected world demand for petroleum products at 54.5 million b/d in 2000. This is up from 50.1 million b/d in 1988. This is a growth of 8.8% over the period.

Under this scenario, demand for OPEC crude oil would move up to a range of 22.5–24.9 million b/d in 1995 from 19.3 million b/d in 1988. This would move up to a production level of 25.5–28 million b/d in 2000. Non-OPEC crude oil and NGL would drop to a range of 24–26 million b/d in 1995 and 22–24 million b/d in 2000. This is down from 26.2 million b/d in 1988. The OPEC share of the market would increase from 39% in 1988 to 42–47% in 1995 and 47–51% in 2000. The paper estimated OPEC production capacity at between 26 million b/d in 1988, moving up to 32 million b/d in 1995 and 35 million b/d in 2000. Therefore, the OPEC operating rate would change from 75% in 1988 to 70–78% in 1995 and 73–80% in 2000.

The paper listed a series of conclusions concerning the worldwide and U.S. outlooks. With respect to the world scene it concluded that there would be moderate demand growth due to:

- Slower economic growth
- Increasing oil prices
- Growing concern over the environment
- Deceleration in new industrial country demand growth
- Growing competition from natural gas

It further concluded that there would also be moderate growth in supply with the following occurring:

- OPEC production capacity will increase.
- Natural gas will be substituted for oil in domestic markets.

Overall it concluded that there will be plenty of oil and that prices are expected to increase gradually.

On the U.S. scene the paper concluded the following:

- Production will continue to decline.
- Rising imports may trigger policies to curb demand and import growth.
- Natural gas will play a growing role in augmenting supply and meeting environmental requirements.
- U.S. dependency and vulnerability will increase.

It further concluded that, "the U.S. needs a comprehensive energy policy."

THE INSTITUTE OF ENERGY ECONOMICS-JAPAN

The Institute of Energy Economics in Japan published the results of a forecast computed from their model of the world energy and markets. This was their "Long term outlook by scenario based upon the world energy supply/demand model."

According to the Institute, "the key factors which can be processed directly with this model, in other words, which can be estimated from the past trends (without assuming structural changes), are OPEC production capacity, nuclear and hydro generated output, energy demand which is presumably symmetrical to prices, and non-OPEC production which rests on parallel changes in oil production cost to on-going trends (without assuming any technological jumps)." They set the assumptions and then run scenarios on their model. These were long range projections through the year 2010.

The basic scenario for the case-A projection they presented included the following assumptions:

OPEC production capacity would move up from 28.1 million b/d in 1987 to 35 million b/d in 2000, and remain at this level to 2010.

Net exports from the communist block would fall from 2.9 million b/d in 1987 to 1.5 million b/d in 2000 and 0 in 2010.

Nuclear generated output would move up from 350,000 tons of oil equivalent in 1987 to 483,000 tons in 2000 and fall to 472,000 tons in 2010.

Hydro generated output would steadily increase and reach 569,000

HIGHLIGHTS
ASHLAND OIL OUTLOOK
(BASE LINE SCENARIO)

	1988	1990	1995	2000
Non-Communist world				
Primary energy demand (Million b/d oil equivalent)				
Oil	50.1	50.9	53.5	54.5
Natural gas	19.0	20.9	24.0	27.0
Coal	23.2	23.7	26.7	29.8
Nuclear	6.9	7.5	9.0	9.8
Hydro & other	8.0	8.3	9.1	10.7
Total energy	**107.2**	**111.3**	**122.3**	**131.8**
Demand (Million b/d)				
U.S.	17.1	17.4	17.8	18.1
Other	33.0	33.5	35.7	36.4
Total demand	**50.1**	**50.9**	**53.5**	**54.5**
Supply (Million b/d)				
Non-OPEC crude and NGL	26.2	25.0-26.0	24.0-26.0	22.0-24.0
Communist exports	2.2	2.0-2.3	1.8-2.2	1.5-2.0
Processing gain & OPEC NGL	2.6	2.6	2.8	3.0
OPEC crude production	19.3	20.0-21.3	22.5-24.9	25.5-28.0
Inventory adjustment	−0.2	—	—	—
Total supply	**50.1**	**50.9**	**53.5**	**54.5**
OPEC				
Capacity (Million b/d)	26.0	30.0	32.0	35.0
Operating rate (%)	75	67-71	70-78	73-80
OPEC market share (%)	39	39-42	42-47	47-51
World oil price ($/bbl)				
Current dollar	13.32	15.00	22.00	30.00
Constant 1988 $	13.32	13.48	15.41	16.00
U.S. oil outlook (Million b/d)				
Consumption	17.1	17.4	17.8	18.1
Supply:				
Domestic crude	8.2	7.7	7.2	6.7
Domestic NGL	1.6	1.6	1.7	1.7
Net imports	6.3	7.0	7.9	8.7
Other supply	1.0	1.1	1.0	1.0
Total supply	**17.1**	**17.4**	**17.8**	**18.1**
Net import % of consumption	37	40	44	48

HIGHLIGHTS
CONOCO WORLD ENERGY OUTLOOK

	1987	1988	2000	Annual rate of change
Non-Communist economic growth	—	—	—	3%
World energy demand (Barrels/day oil equivalent)	—	108	135	2%
Oil's share of energy market	45%	—	43%	—
World oil demand				
(Million barrels/day)	48	—	58	1.5%
Motor gasoline	—	—	—	1.5%
Jet fuel	—	—	—	2.5%
Distillate	—	—	—	1.7%
Residual fuel oil	—	—	—	1.0%
U.S. energy demand	—	—	—	1.5%
Coal	—	—	—	2.0%
U.S. oil demand				
(Million barrels/day)	16.7	—	19.5	1.0%
Motor gasoline	—	—	8.0	1.0%
Kerosine fuel	—	—	—	2.5%
Distillate	—	—	—	1.5%
U.S. crude oil production	—	—	—	−2.5%
U.S. imports				
(Million barrels/day)	6.0	—	11.0	—
Import % of demand	—	37%	55%	—

HIGHLIGHTS
THE INSTITUTE OF ENERGY ECONOMICS—JAPAN

Basic scenario—Case A	**1987**	**1995**	**2000**	**2005**	**2010**
OPEC production capacity (Million b/d)	28.1	31.7	35.0	35.0	35.0
Net exports from Communist areas (Million b/d)	2.9	1.9	1.5	1.1	0.8
Nuclear generated output (Thousands tons oil equivalent)	350	468	483	482	472
Hydro generated output (Thousand tons oil equivalent)	415	507	569	624	707
Simulation results—Case A	**1986**	**1995**	**2000**	**2005**	**2010**
Free World real GDP (1980 US $)	12,395	16,123	18,229	20,544	23,199
Free World energy demand (Thousand tons oil equivalent)	4,941	6,047	6,729	7,569	8,562
Free World oil production (Million b/d)					
Non-OPEC	22.6	24.1	24.7	25.2	24.4
OPEC	19.1	25.2	28.1	28.0	28.6
Free World energy demand (Thousand tons oil equivalent)					
Coal	1,082	1,417	1,711	2,149	2,604
Natual gas	887	1,117	1,282	1,472	1,695
Nuclear	330	468	483	482	472
Hydro	413	507	569	624	707
Real crude oil prices ($/bbl — 1987 $)	14.00	30.60	37.70	45.30	50.30

tons of oil equivalent in 2000 and 707,000 tons in 2010.

The simulation results from the model run presented projections for a number of key economic and energy industry parameters. The results were as follows:

Free world economic activity would increase at a rate of 3.1%/year until 1995. Between 1995 and 2010 the growth rate would be slowed to 2.4–2.5%/year.

Free world primary energy demand would move up at a rate of 2.2–2.3%/year from now until 2000. It would accelerate to 2.4–2.5% for the period beyond 2000.

Non-OPEC free world oil production will increase at a rate of 0.7%/year until 1995. The growth rate will slow to 0.4%/year from 1995–2005. Production will then start to decline at a rate of -0.7%/year until 2010.

Real crude oil prices will increase at a rate of 9.1%/year through 1995. The rate of increase in prices will be 4.3% from 1995–2000, 3.7% from 2000–2005 and 2.1% from 2005–2010.

CONOCO

In 1989 Conoco published their projection "World Energy Outlook, Through 2000." This report was an overview of their expectations for the worldwide energy and oil and gas industries through the year 2000.

The Conoco outlook was based on a set of assumptions concerning several key factors which determine energy supply and demand. Following are some of the assumptions.

- **Economic growth.** The non-communist world economies will grow at a rate of slightly more than 3%/year. The U.S. and European economies will grow at a slightly slower rate while Japanese economic growth will be almost 1% higher.
- **Oil prices.** Prices remain low for several years, between $10 and $20 per barrel (constant 1988 $), and then rise slightly through 1995 toward an upper boundary around $24 per barrel.
- **Natural gas prices.** Natural gas prices will remain competitive with oil products in most markets through 2000.
- **Coal prices.** Coal will continue to compete with oil and gas in the new boiler market. Coal supply will increase as new low cost coal is produced throughout the world. However, changing environmental standards make the outlook for this market uncertain.
- **Nuclear power.** High plant construction costs and safety concerns will limit the growth of nuclear power. No new capacity will be added in the U.S. Some countries have begun to phase out existing nuclear capacity for safety reasons. Fossil fuels will be needed to replace the loss of electric generating capacity.
- **Renewables.** Hydroelectric power will be the only renewable energy source to significantly increase its contribution to energy supplies, although limited to select areas.

Those are the basic assumptions behind the Conoco outlook. Following is a summary of some of the significant projections in their forecast.

"World energy demand is expected to grow 2%/year during the 1989-2000 time period. Developing nations will account for nearly half of the total increase.

The shift away from oil and gas has been slowed by the increased competitiveness of oil and gas prices. As a result, oil and gas together will provide over 60% of world energy supply by 2000.

World oil demand will grow 1.5%/year through 2000, with over half of the increase in developing nations. Transportation will continue to be the fastest growing market for oil.

The drop in oil prices in recent years will stem the growth in non-

HIGHLIGHTS
ENERGY INFORMATION ADMINISTRATION
OUTLOOK FOR OIL AND GAS
(BASE CASE)

	1988	1989	1990	1991	1992	1993	1994	1995	2000
World oil price ($/barrel)									
Real price (1988 $)	14.64	14.40	15.00	15.50	15.90	17.10	18.90	20.60	28.00
U.S. demand (Million bbl/day)									
Refined petroleum products supplied									
Motor gasoline	7.34	7.44	7.46	7.32	7.25	7.24	7.21	7.18	7.23
Jet fuel	1.45	1.50	1.52	1.53	1.55	1.58	1.60	1.61	1.70
Distillate fuel	3.12	3.26	3.29	3.34	3.39	3.44	3.48	3.50	3.67
Residual fuel	1.38	1.23	1.33	1.33	1.36	1.39	1.45	1.48	1.61
Other products	4.00	3.80	3.88	3.96	4.00	4.04	4.05	4.08	4.32
Total products supplied	**17.28**	**17.23**	**17.48**	**17.49**	**17.56**	**17.68**	**17.80**	**17.85**	**18.54**
Exports	0.82	0.75	0.83	0.83	0.83	0.83	0.83	0.83	0.83
U.S. supply (Million bbl/day)									
Alaska crude production	2.02	2.01	1.96	1.80	1.62	1.51	1.41	1.29	0.91
Lower-48 crude production	6.12	5.96	5.73	5.47	5.22	5.04	4.89	4.76	5.08
Total crude production	**8.14**	**7.97**	**7.69**	**7.27**	**6.84**	**6.55**	**6.30**	**6.05**	**5.99**
NGL production	1.62	1.62	1.72	1.76	1.77	1.79	1.79	1.81	1.89
Imports (including SPR)									
Crude oil	5.11	5.54	6.14	6.45	6.91	7.26	7.59	7.82	8.32
Products	2.30	2.04	2.15	2.21	2.27	2.32	2.37	2.41	2.53
Total imports	**7.40**	**7.58**	**8.30**	**8.65**	**9.17**	**9.58**	**9.96**	**10.23**	**10.84**
Refined petroleum products supplied by sector (Million bbl/day)									
Residential and commercial	1.44	1.44	1.43	1.41	1.40	1.39	1.38	1.36	1.30
Industrial	4.34	4.27	4.34	4.39	4.44	4.48	4.50	4.53	4.79
Transportation	10.92	10.94	11.04	10.97	10.96	11.01	11.02	11.04	11.33
Electric Utilities	0.59	0.51	0.59	0.64	0.68	0.72	0.83	0.86	1.05
Total consumption	**17.28**	**17.15**	**17.40**	**17.41**	**17.48**	**17.61**	**17.73**	**17.78**	**18.47**
Natural gas:									
U.S. Supply (Trillion cubic feet)									
Dry gas production	16.64	16.93	17.02	17.40	17.36	17.59	17.65	17.82	18.58
Supplemental natural gas	0.14	0.07	0.07	0.07	0.15	0.16	0.15	0.15	0.15
Net imports	1.18	1.35	1.43	1.52	1.61	1.69	1.77	1.87	2.30
Total supply	**17.84**	**18.34**	**18.52**	**18.98**	**19.12**	**19.44**	**19.56**	**19.84**	**21.02**
Consumption									
Residential and commercial	7.31	7.29	7.23	7.32	7.31	7.28	7.23	7.20	6.97
Industrial	6.39	6.22	6.27	6.47	6.49	6.45	6.41	6.35	6.09
Electric Utilities	2.63	2.81	2.98	3.11	3.22	3.57	3.74	4.07	5.57
Other	1.70	1.57	1.57	1.60	1.62	1.65	1.68	1.71	1.82
Total consumption	**18.04**	**17.89**	**18.05**	**18.50**	**18.63**	**18.95**	**19.06**	**19.32**	**20.45**
Natural gas price ($/MCF) (Real price - 1988 $)									
Average wellhead price	1.71	1.66	1.77	1.93	2.11	2.32	2.53	2.76	3.90
Average delivered price	3.84	3.81	3.82	3.95	4.09	4.25	4.46	4.66	5.77

OPEC production within a few years, and incremental supplies will come from OPEC producers with large reserves.

U.S. energy demand will grow 1.5%/year. The contribution of coal and nuclear power in the total energy mix will increase moderately, but oil and gas consumption also will continue to grow.

Demand for U.S. coal will increase at a rate of 2%/year. The electric utility sector will remain coal's principal market, accounting for over 85% of U.S. coal consumption.

U.S. nuclear power generation will increase 4%/year through 1992 and then rise slowly the remainder of the decade.

Natural gas demand in the U.S. will increase slowly through the early 1990's. Then, growing requirements of electric utilities will increase consumption to more than 19 tcf/year by 2000.

U.S. oil demand is expected to grow about 1%/year through the year 2000. There is potential demand for an additional 2 million b/d of residual fuel if oil prices remain too low to spur the search for new gas reserves needed to meet the projected demand for gas.

U.S. crude oil production will fall by 2.5%/year through 2000, resulting in a decline of more than 2 million b/d. Oil imports will rise

HIGHLIGHTS
CANADIAN ENERGY RESEARCH INSTITUTE
STUDY OF THE WORLD OIL MARKET*

	1988	1989	1990	1991	1992	1993	1994	1995	2000
Crude oil price ($/bbl) WTI—1987 U.S. $	17.50	18.54	19.40	19.82	20.69	21.06	21.78	22.53	26.90
World oil demand by region (Thousand barrels/day)									
Canada	1,505	1,503	1,503	1,505	1,507	1,513	1,517	1,524	1,559
United States	16,878	17,061	17,156	17,272	17,349	17,440	17,504	17,572	17,916
Western Europe	12,423	12,516	12,538	12,560	12,543	12,549	12,538	12,520	13,343
Pacific OECD	5,118	5,141	5,155	5,178	5,197	5,225	5,244	5,261	5,339
Less Developed Countries	9,876	10,091	10,288	10,497	10,690	10,987	11,103	11,304	12,231
OPEC	3,816	3,879	3,947	4,028	4,118	4,221	4,331	4,450	5,132
Central Planned Economies (CPE)	13,644	13,811	14,002	14,193	14,394	14,595	14,820	15,065	16,260
Total world demand	**63,260**	**64,003**	**64,589**	**65,232**	**65,798**	**66,440**	**67,057**	**67,695**	**70,780**
World crude oil production summary (Thousand barrels/day)									
Non-OPEC crude oil	23,017	23,321	23,520	23,696	23,741	23,607	23,413	23,174	21,341
Non-OPEC NGL's	2,798	2,785	2,774	2,764	2,755	2,747	2,740	2,733	2,716
Total Non-OPEC liquids	**28,515**	**26,107**	**26,295**	**26,461**	**26,496**	**26,354**	**26,153**	**25,908**	**24,058**
OPEC crude	18,800	19,300	19,450	19,800	20,400	21,300	22,000	22,800	27,400
OPEC NGL's	1,443	1,479	1,516	1,554	1,593	1,633	1,675	1,718	1,952
Total OPEC liquids	**20,243**	**20,779**	**20,966**	**21,354**	**21,993**	**22,933**	**23,675**	**24,518**	**29,352**
Central Planned Economies	15,810	16,010	16,220	16,310	16,200	16,090	16,120	16,160	16,260
TOTAL	**62,969**	**63,996**	**64,561**	**65,225**	**65,790**	**66,478**	**67,049**	**67,686**	**70,771**
Net exports from CPE	2,170	2,200	2,220	2,120	1,810	1,500	1,300	1,100	0

* Reference Crude Oil Market Scenario

from 6 million b/d in 1987 to 11 million b/d in 2000."

CANADIAN ENERGY RESEARCH INSTITUTE

The Canadian Energy Research Institute issued the results of a study they did on the fundamentals of a medium to long term outlook for the world oil market. The report they issued was titled "Stability Within Uncertainty: Evolution of the World Oil Market." The report contains several projections through the year 2000 derived from their World Oil Market model.

What might be considered their base case projection is referred to as the "reference crude oil market scenario." It is defined in the report as follows: "The reference crude oil market scenario reflects the combined judgement of the authors as to the most likely path for crude oil prices, given a rational and well-behaved market and the absence of unforeseeable supply and demand shocks." According to the report, they chose a reasonable set of assumptions regarding production levels for OPEC over time, non-OPEC supply potential, economic growth rates around the world and the responsiveness of oil demand to changes in price and economic growth rates.

Some of the key comments in the study with respect to the reference scenario follow.

"OPEC production is assumed to average 18.8 million b/d in 1988. Between 1989 and 1991 the ability, and the desire, of the cartel to increase production is assumed to be mitigated by increases in non-OPEC production. During this period, the cartel's average annual daily output is assumed to grow by less than 2%/year. After 1991 the ability of OPEC to take advantage of world oil demand growth and stagnant non-OPEC output allows OPEC production to increase at an average annual rate of roughly 3.5%/year. OPEC production in the year 2000 reaches 27.4 million b/d, a level that is 46% higher than current levels but significantly below the cartel's current productive capacity of 34 million b/d.

"The principal trend is for slowly rising prices through to the mid-1990's, followed by slightly accelerated price increases (averaging 3.7%/year) over the remaining years of the forecast horizon. Prices reach $22.50/bbl by 1995 and $26.90/bbl by the year 2000. All prices are in constant 1987 dollars for West Texas Intermediate crude.

"The near term growth in crude

oil prices is made possible by increased levels of world oil consumption over the next 3 years, triggered largely by the steady fall in prices over the period 1982–1987. Oil consumption outside the centrally planned economies (CPE's) is projected to increase by more than 1 million b/d between 1987 and 1990. Rising real oil prices dampen the rate of growth in consumption to less than 1%/year through the mid-1990's. From 1995 to the end of the century, growth in oil consumption is expected to strengthen slightly to about 1.1%/year as the dampening effects of rising oil prices are more than offset by continued economic growth. Non-CPE oil consumption is projected to reach 54.4 million b/d by the year 2000."

The Canadian Energy Research Institute used their World Oil Market model to look at six plausible alternative scenarios. Two of those scenarios were summarized as follows:

"The High Resource Scenario is predicated on the surprising resilience of non-OPEC production in the face of declining crude oil prices over the last 5 years and the constant upward revision of estimates of ultimate recoverable resources in the non-OPEC regions. In this scenario we set ultimate crude oil reserves at the optimistic 5% probability level. And the result is to increase projected finding rates in each region and hence productive capacity over the forecast horizon.

"With OPEC production held at the same levels as in the reference scenario, the increase in non-OPEC production generates a significantly lower price path than in the reference scenario. Prices fall over 7% in 1988 to $16.80/bbl recovering to $22.40/bbl by the year 2000, some 20% lower than under the reference case."

The High Resource Scenario provides what the study describes as "a very legitimate low price projection." They give it equal probability of occurrence as the reference case.

The other scenario is the Competitive Market Scenario, which is, "an attempt to arrive at a reasonable price floor for crude oil and to investigate the evolution of a non-cartelized oil market." According to the report, "The scenario is based on a breakdown of OPEC in 1989. The countries currently in OPEC are assumed to return to previous productive capacity over the ensuing 3 to 4 years, yielding combined production in 1993 of some 33.4 million b/d. In subsequent years, an additional 1 million b/d of capacity is brought on stream each year–three quarters of this in the reserves-rich Persian Gulf nations of Saudi Arabia, Kuwait, Qatar and the U.A.E., and the remainder in the other OPEC countries.

"The world price of oil quickly falls to an average of just over $11.00/bbl in 1989, with a further decline to $9.00/bbl by 1991. In 1993 after four consecutive years of very low oil prices, a huge surge in world oil consumption becomes the dominant feature of world oil trade and prices begin to slowly recover. Prices rebound to $12.00/bbl in 1993 and reach $16.00/bbl by the end of the century. World oil consumption reaches 80 million b/d by the year 2000."

The interesting element of this scenario is the establishment of a floor price for crude oil of $9.00/bbl. And then the subsequent increase in prices. The report states that, "one would expect downward price spikes, of short duration, to fall below $9.00/bbl. However, the re-establishment of a gradual upward trajectory for crude oil prices would still occur. This is the basic stability within uncertainty which results from the fundamental supply and demand characteristics underlying the world oil market."

This interesting study also relates some advice to industry analysts, "those involved in the oil market should focus their attention more on the fundamentals of the market, and less on the short-term fluctuations and volatility of the world oil market."

OPEC

■

Over the forecast period 1989–1994, events in the worldwide and U.S. oil and gas industry will be dictated to a large extent by decisions made by OPEC. The Organization of Petroleum Exporting Countries (OPEC) has had considerable influence over the worldwide oil industry for the last 10–15 years. The level of influence has varied over the past ten years along with the demand for OPEC oil. But OPEC's influence once again appears to be on the rise.

This influence extends to all aspects of the energy industry. This is because OPEC has the greatest influence over the determination of the worldwide price of crude oil. And the price of oil has an impact and connection to the price of other competing forms of energy. So OPEC's decisions influence the level of activity in the oil and gas industry and in other energy industries as well.

OPEC today, as in the past, is in a position to have a major impact on the price of crude oil worldwide. The price of crude oil will in turn influence the level of petroleum product demand, the supply of crude oil outside of OPEC, and the level of competition from other energy forms.

OPEC has had many problems within the organization with respect to determining a level of production and prices that will satisfy all of the thirteen member countries. The internal struggles have led to constantly changing policies and actions by OPEC. And this has kept the worldwide oil and gas industry in a state of turmoil for the past 10–15 years.

This section takes a close look at OPEC and the many changes that have taken place in the industry due to OPEC actions. It also looks closely at the reasons why OPEC has considerable influence over the oil market. And it points out why OPEC has had problems with controlling the market.

THE ORGANIZATION. OPEC was formed in 1960 with the original participating countries being Iran, Iraq, Kuwait, Saudi Arabia and Venezuela. It has since grown to include 13 countries. The thirteen member countries and the year they joined OPEC is listed below:

1960 Iran
Iraq
Kuwait
Saudi Arabia
Venezuela
1961 Qatar
1962 Indonesia
Libya
1967 Algeria
Abu Dhabi (now part of UAE)
1971 Nigeria
1973 Ecuador
Gabon
1974 United Arab Emirates:
Abu Dhabi
Dubai
Ras al Khaymah
Sharjah

From time to time OPEC has made overtures to other petroleum exporting countries, to determine if they had an interest in joining with the cartel. But the OPEC cartel has remained at a group of thirteen since 1974. Some of the other major exporting countries are Mexico, Norway, Angola, Egypt and the United Kingdom.

OPEC GAS PRODUCTION
1988

Country	Gross	Marketed	Reinjected	Flared	Other losses
	(Billion cu ft)				
Algeria	3,882	1,586	1,872	212	213
Ecuador	25	3	1	22	0
Gabon	62	4	12	44	2
Indonesia	1,826	1,272	314	152	17
Iran	1,430	706	530	141	53
Iraq	377	202	0	159	16
Kuwait	317	229	4	32	53
Libya	441	194	141	91	15
Nigeria	648	134	81	433	0
Qatar	258	228	0	0	30
Saudi Arabia	1,596	1,028	106	117	346
United Arab Emirates	979	658	125	79	82
Venezuela	1,338	695	420	127	96
Total OPEC	**13,181**	**6,940**	**3,607**	**1,608**	**921**
% of Total OPEC	**100.0**	**52.6**	**27.4**	**12.2**	**7.0**
Total World	**84,340**	**69,198**	**7,386**	**3,263**	**3,785**
% of Total World	**100.0**	**82.0**	**8.8**	**3.9**	**4.5**

Source: Cedigaz

OPEC TOTAL LIQUIDS PRODUCTION
(CRUDE OIL, CONDENSATE, NGL)

Country	1979	1982	1985	1987	1988
	(000 b/d)				
Algeria	1,255	1,045	970	1,040	1,070
Ecuador	215	200	275	165	300
Gabon	205	155	155	155	170
Indonesia	1,590	1,415	1,335	1,320	1,315
Iran	3,175	2,410	2,215	2,310	2,275
Iraq	3,475	1,010	1,440	2,090	2,600
Kuwait	2,270	705	920	1,075	1,340
Libya	2,090	1,135	1,105	1,000	1,055
(Neutral Zone)	570	315	340	390	320
Nigeria	2,300	1,285	1,475	1,290	1,365
Qatar	510	340	340	340	360
Saudi Arabia	9,555	6,695	3,565	4,360	5,255
United Arab Emirates	1,830	1,255	1,350	1,720	1,795
Venezuela	2,425	1,965	1,730	1,775	1,925
Total OPEC	**31,465**	**19,930**	**17,215**	**19,030**	**21,145**
Total Non-Communist	**51,280**	**42,075**	**42,465**	**44,025**	**46,320**
Total World	**65,775**	**57,060**	**57,595**	**59,895**	**62,195**
OPEC SHARE:					
% Non-Communist	**61.4**	**47.4**	**40.5**	**43.2**	**45.6**
% Total World	**47.8**	**34.9**	**29.9**	**31.8**	**34.0**

Source: British Petroleum

PRODUCTION. From its inception OPEC production moved up steadily and rapidly. OPEC production statistics were first tabulated in 1961, and output was 9.364 million b/d. At the start the OPEC countries accounted for 41.8% of total world production and 50.1% of non-communist production. Output moved up rapidly to 30.989 million b/d in 1973. In that year OPEC output was 55.5%

OPEC RESERVES
CRUDE OIL

Country	1976	1979	1982	1985	1988	1989
	Jan. 1 (Million bbl)					
Saudi Arabia	148,600	165,700	164,600	169,000	166,980	169,970
Iraq	34,300	32,100	29,700	44,500	100,000	100,000
United Arab Emirates	32,200	31,316	32,176	32,490	98,105	98,105
Iran	64,500	59,000	57,000	48,500	92,850	92,850
Kuwait	68,000	66,200	64,480	90,000	91,920	91,920
Venezuela	17,700	18,000	20,300	25,845	56,300	58,084
Libya	26,100	24,300	22,600	21,100	21,000	22,000
Nigeria	20,200	18,200	16,500	16,650	15,980	16,000
Algeria	7,370	6,300	8,080	9,000	8,500	8,400
Indonesia	14,000	10,200	9,800	8,650	8,400	8,250
(Neutral Zone)	6,400	6,480	6,500	5,420	5,210	5,210
Qatar	5,850	4,000	3,434	3,350	3,150	3,150
Ecuador	2,450	1,170	850	1,400	1,615	1,350
Gabon	2,200	1,970	480	510	645	720
Total OPEC	**499,870**	**444,936**	**436,500**	**476,415**	**670,655**	**676,009**
Non-OPEC Countries	**55,816**	**102,672**	**148,364**	**138,152**	**137,493**	**147,634**
Total Non-Communist	**555,686**	**547,608**	**584,864**	**614,567**	**808,148**	**823,643**
Total World	**659,086**	**641,608**	**670.709**	**698,667**	**887,348**	**907,443**
OPEC SHARE:						
% Non-Communist	**90.0**	**81.3**	**74.6**	**77.5**	**83.0**	**82.1**
% World	**75.8**	**69.3**	**65.1**	**68.2**	**75.6**	**74.5**

OPEC RESERVES
NATURAL GAS

Country	1978	1983	1986	1989	Gross production 1988 (Bcf)	Production/ Reserves (Years)
	Jan. 1 (Billion cu ft)					
Saudi Arabia	85,000	117,000	121,000	145,848	1,596	91
Iraq	28,000	28,800	29,000	95,000	377	252
United Arab Emirates	21,500	28,580	32,800	201,515	817	247
Iran	500,000	482,600	470,000	494,400	1,430	346
Kuwait	31,500	29,900	32,500	42,500	317	134
Venezuela	41,000	54,079	59,067	102,243	1,338	76
Libya	25,700	21,500	21,390	25,700	441	58
Nigeria	43,000	32,400	47,000	85,000	648	131
Algeria	125,000	111,250	107,080	104,200	3,882	27
Indonesia	24,000	29,600	35,600	83,590	1,826	46
(Neutral Zone)	5,000	8,380	8,210	12,300	—	—
Qatar	40,000	62,000	148,000	156,700	258	607
Ecuador	5,000	4,100	4,090	4,020	25	158
Gabon	2,450	485	420	600	62	10
Total OPEC	**977,150**	**1,010,674**	**1,116,157**	**1,553,616**	**13,019**	**119**
Non-OPEC Countries	**587,509**	**754,053**	**821,903**	**841,025**	**40,499**	**21**
Total Non-Communist	**1,564,659**	**1,764,727**	**1,938,060**	**2,394,641**	**53,518**	**45**
Total World	**2,519,659**	**3,023,527**	**3,484,060**	**3,955,341**	**84,340**	**47**
OPEC SHARE:						
% Non-Communist	**62.5**	**57.3**	**57.6**	**64.9**		
% World	**38.8**	**33.4**	**32.0**	**39.3**		

of world production and 67.5% of non-communist world production. This was also the time that OPEC first pushed up the price of crude oil.

In 1975, OPEC output dropped to 27.155 million b/d, due to the higher oil prices and an economic recession in some of the industrial countries. With renewed worldwide economic growth OPEC production rebounded to 31.298 million b/d in 1977. This was just before the major price hikes in the years 1979–1981. OPEC output stayed at close to this level for the next few years and was at 30.928 million b/d in 1979. At this point OPEC started sharply raising crude oil prices.

The sharp increase in prices that then took place had a substantial impact on product demand. Conservation, fuel switching, and economic stagnation all worked together to reduce demand for petroleum products. The drop in demand and competition from non-OPEC production combined to have a major impact on OPEC output.

Production fell steadily and reached a recent low of 16.039 million b/d in 1985. This was a drop 48.1%, 14.889 million b/d, from 1979. In 1985, OPEC production represented only 29.9% of total world output and 42.4% of non-communist production. The aggressive pricing policy adopted by OPEC had made it the swing producer or crude supplier of last resort for the consuming countries.

Consumers invested in conservation equipment or adopted conservation measures to reduce energy and oil consumption. Where possible, consumers also switched to other cheaper fuel sources. This substantially reduced the demand for crude oil and most of the reduction was in demand for OPEC oil.

In addition, the high prices stimulated exploration and production elsewhere in the world. This enabled some countries to replace costly OPEC imports. It also resulted in the development of competing export countries. These countries could profitably undercut OPEC prices and capture OPEC market share. As a result, consuming importing countries only called upon expensive OPEC crude oil to fill the gap between the required imports to fuel economic growth and imports from cheaper non-OPEC sources.

When OPEC production fell it

OPEC-PRODUCTION CAPACITY

Country	Production		Excess capacity	% utilization
	Capacity	Av. 1988 (000 b/d)		
Algeria	900	641	259	71.2
Ecuador	330	305	25	92.4
Gabon	200	175	25	87.5
Indonesia	1,700	1,138	562	66.9
Iran	3,600	2,240	1,350	62.2
Iraq	2,700	2,688	12	99.6
Kuwait	2,200	1,335	865	60.7
Libya	1,600	1,025	575	64.1
(Neutral Zone)	600	313	287	52.2
Nigeria	1,800	1,390	410	77.2
Qatar	600	346	254	57.7
Saudi Arabia	8,700	4,946	3,754	56.9
United Arab Emirates	2,070	1,474	596	71.2
Venezuela	2,500	1,649	851	66.0
Total OPEC	**29,500**	**19,665**	**9,835**	**66.7**

OPEC PETROLEUM PRODUCT PRODUCTION — CONSUMPTION — EXPORT

1987

	Refinery production	Domestic consumption (1,000 b/d)	Exports
Algeria	431.0	148.7	449.0
Ecuador	77.6	78.9	15.6
Gabon	8.4	12.5	1.5
Indonesia	548.9	452.1	183.0
Iran	519.9	730.5	—
Iraq	353.7	283.8	130.0
Kuwait	575.0	88.4	510.0
Libya	220.3	131.9	125.5
(Neutral Zone)	—	—	—
Nigeria	139.2	198.4	7.1
Qatar	32.4	11.2	25.0
Saudi Arabia	1,386.8	614.5	864.8
United Arab Emirates	171.8	90.0	114.0
Venezuela	903.2	377.7	492.3
Total OPEC	**5,368.2**	**3,218.6**	**2,917.8**

Source: OPEC Statistical Bulletin

OPEC-CRUDE EXPORTS

Country	1979	1983 (000 b/d)	1987	Volume change 1987/79	% change 1987/79
Algeria	960.4	260.4	165.0	−795.4	−82.8
Ecuador	122.6	126.3	99.0	−23.6	−19.2
Gabon	164.8	136.4	138.4	−26.4	−16.0
Indonesia	1,077.7	858.3	686.0	−391.7	−36.3
Iran	2,407.0	1,718.7	1,710.0	−697.0	−29.0
Iraq	3,275.3	725.4	1,704.0	−1,571.3	−48.0
Kuwait	2,083.1	544.4	511.3	−1,571.8	−75.5
Libya	1,966.0	937.4	765.0	−1,201.0	−61.1
(Neutral Zone)					
Nigeria	2,210.1	935.2	1,107.0	−1,103.1	−49.9
Qatar	494.9	268.3	265.0	−229.9	−46.5
Saudi Arabia	8,817.7	3,920.8	2,623.0	−6,194.7	−70.3
United Arab Emirates	1,805.3	1,077.3	1,215.0	−590.3	−32.7
Venezuela	1,408.3	976.7	1,024.7	−383.6	−27.2
Total OPEC	**26,793.2**	**12,485.6**	**12,013.4**	**−14,779.8**	**−55.2**

Source: OPEC Statistical Bulletin.

PRICES — DEMAND — OPEC PRODUCTION

	1975	1979	1983	1987	1988
Crude oil price — Saudi Light ($/bbl)	12.35	24.00	34.00	17.53	13.71
Non-Communist product demand (000 b/d)	44,575	51,280	44,965	48,075	49,765
OPEC production (000 b/d)	27,535	31,465	18,425	19,030	21,145

left behind a substantial volume of excess crude oil production capacity in a number of the OPEC countries. The excess capacity created an element of competition between OPEC member countries. Coupled with competition from increasing non-OPEC production this put downward pressure on prices.

Prices slid gradually after hitting a peak in 1981 and 1982. The slow price slide continued through 1983, 1984 and 1985. OPEC adopted a quota system in 1983 in an attempt to prop up prices and stop the slide. Due mainly to the production cuts by Saudi Arabia, this restraint on production prevented a rapid deterioration of prices during this period.

However, in 1985 Saudi Arabia grew tired of unilaterally propping up prices. Because the other OPEC countries did not cooperate, the Saudis were required to make massive production cuts to prevent a decline in prices. Saudi Arabia decided on a new policy and set out to secure an acceptable portion of the market. Then at the start of 1986 OPEC as a whole attempted to try to regain some of their lost market share through price competition. The result was an extended period of over production and a collapse in prices. OPEC production moved up to 18.074 million b/d in 1986. But there was a substantial loss of revenue since the price decline was far greater than the increase in production.

OPEC abandoned the market share objective in late 1986 and returned to production quotas as a means of trying to stabilize the market at an acceptable price. OPEC adopted new production quotas in September 1986 and prices firmed. But prices firmed at a level about 30% lower than 1985 and 50% below the peak years.

As a result of the increase in prices, demand for OPEC oil fell again and OPEC production dropped to 18.584 million b/d in 1987. In 1988 competition developed again among the OPEC countries with excess capacity. That year a number of the countries exceeded the quotas and pushed excess crude onto the market. And prices fell sharply again in 1988. OPEC output moved up sharply to an estimated 20.539 million b/d. But again, for OPEC as a whole, substantial revenue was sacrificed for market share. However, individual countries may have increased production sufficiently to gain in revenue. The countries that were hurt the most were those without a large level of excess capacity that, therefore, could not boost production.

OPEC EXCESS CAPACITY. The major reasons why OPEC has had such difficulty with controlling world prices is the massive excess crude oil production capacity in the member countries.

The capacity exists because it was developed to satisfy growing world demand for crude oil. Worldwide demand for petroleum was on a steady upward trend throughout the 1950's, 1960's and 1970's. In general, the growth in worldwide economic activity was being fueled by petroleum—low cost petroleum. The international oil companies controlled most of the world crude oil import/export trade. The huge oil reserves they found, mostly in the OPEC countries, enabled them to increase output at a pace to satisfy the increase in world demand. They increased output capacity in line with their projections of growth in demand. They generally operated at a sustainable capacity level of 90–95% of installed developed capacity. This left a small excess capacity for contingencies and for maintenance downtime.

When the OPEC countries finally took control of most of their own production, the total OPEC installed capacity was over 30 million b/d and climbing. The sharp escalation in prices that took place in the 1970's and into the early 1980's brought about a reduction in demand for petroleum. As a result the gap between available capacity and production grew rapidly. This new excess capacity was a readily available developed capacity that could be utilized without resorting to costly investment.

The worldwide excess capacity grew to 10–15 million b/d during the 1983–1986 period, with the vast majority in OPEC countries. And the excess capacity is still estimated at 7–12 million b/d. This represents excess capacity of close to 25% of present free world demand for crude oil.

Some capacity was eliminated due to the Iran/Iraq war and due to long periods of inactivity. However, it is felt that even a substantial portion of this can be brought back on stream with some investment. And the huge reserves in some of the OPEC countries could easily be exploited if a substantial exploration effort was launched. Thus, additional capacity might be readily available with a relatively short lead time.

This overhanging excess capacity makes it easy for individual OPEC countries to increase output if they see an opportunity to increase their market share. This has resulted in periodic "cheating" on quotas and competition within OPEC. This has helped maintain continuous downward pressure on prices. This downward pressure will remain until increasing demand eliminates a sufficient portion of this excess capacity.

OPEC QUOTAS AND THE PRICE LEVEL. In 1983 OPEC recognized that the only way they could prevent a rapid slide in prices was to restrict production. They recognized that by balancing world supply and demand it would be possible to slow and possibly stop the decline in prices.

World export prices had peaked in 1981 at about $35.50/bbl. OPEC prices were $34.80/bbl and non-OPEC prices $38.50/bbl. When demand started to slide, non-OPEC export producers undercut OPEC prices to retain market share. With this intense competition in the market world export posted prices fell to $33/bbl in January 1983. The OPEC price was $33.50/bbl and the non-OPEC price $31.70/bbl.

OPEC adopted their first set of quotas in March 1983 at 17.5 million b/d. Even with the OPEC production quotas prices continued to slide. Therefore, in a renewed attempt to balance the market OPEC lowered the quota to 16 million b/d in November 1984. Adoption of this lower production level did manage to support prices throughout 1984 and 1985.

But a disproportionate share of the cut in OPEC production was being borne by Saudi Arabia. They had adopted or accepted the role of swing producer within OPEC. They cut their production to help

OPEC PRODUCTION/RESERVES RATIO

Country	Reserves Jan. 1, 1989 (Million bbl)	Production Av. 1988 (000 b/d)	Production July 1989 (000 b/d)	Production/ Reserves (Years)
Saudi Arabia	169,970	4,946	4,900	94–95
Iraq	100,000	2,688	2,760	102–99
United Arab Emirates	98,105	1,474	1,800	182–149
Iran	92,850	2,240	2,600	114–98
Kuwait	91,920	1,335	1,600	189–157
Venezuela	58,084	1,649	1,850	97–86
Libya	22,000	1,025	1,150	59–52
Nigeria	16,000	1,390	1,800	32–24
Algeria	8,400	641	700	36–33
Indonesia	8,250	1,138	1,250	20–18
(Neutral Zone)*	5,210	313	400	46-36
Qatar	3,150	346	330	25–26
Ecuador	1,350	305	285	12–13
Gabon	720	175	215	11–9
Total OPEC	**676,009**	**19,665**	**21,640**	**94–86**
United States	**26,500**	**8,115**	**7,622**	**8.9–9.5**
All Non-OPEC Countries	**147,634**	**22,744**	**22,463**	**17.8–18.0**
Total Non-Communist	**823,643**	**42,409**	**44,103**	**53.2–51.2**
Communist	**83,800**	**15,586**	**15,310**	**14.7–15.0**
Total World	**907,443**	**57,995**	**59,413**	**42.9–41.8**

*Production shared by Kuwait and Saudi Arabia.
Source: Oil & Gas Journal

VALUE—OPEC PETROLEUM EXPORTS

Year	Crude exports (1,000 b/d)	Product exports (1,000 b/d)	Total exports (1,000 b/d)	Value of exports ($ million)	Average value ($/bbl)
1980	22,843.7	2,011.1	24,854.8	286,984	31.55
1981	18,424.0	1,980.6	20,404.6	265,146	35.60
1982	14,235.2	2,276.3	16,511.5	206,655	34.29
1983	12,485.6	2,045.8	14,531.4	161,260	30.40
1984	11,983.0	2,290.9	14,273.9	148,473	28.42
1985	10,810.5	2,457.0	13,267.5	130,681	26.99
1986	12,779.6	2,730.7	15,510.3	78,834	13.93
1987	12,013.4	2,917.8	14,931.2	95,699	17.56
Average	14,446.9	2,338.8	16,785.7	171,717	28.03

Source: OPEC Statistical Bulletin

OPEC stay within the quota and prevent a fall in crude prices. By 1985, Saudi production had fallen to an average of 3.175 million b/d. This was down 6.633 million b/d, 67.6% from 9.808 million b/d in 1981. Total OPEC production had fallen only 6.502 million b/d, 28.8%. With the Saudi's willing to play the swing producer role, many of the other OPEC members could sustain their production and not have to sacrifice output to support prices.

In the summer of 1985, Saudi production fell below 2 million b/d and they realized that supporting the OPEC quota unilaterally could be disastrous. At this point they abandoned the swing producer role and adopted a "net-back pricing" scheme to recapture market share. This introduced price competition among OPEC members. Other OPEC countries followed. In December that year OPEC adopted a market share goal and abandoned the goal of supporting a price level. This made an excessive volume of crude oil available on the market. When winter petroleum demand subsided in early 1986, prices collapsed.

The average export price of OPEC crude fell below $10/bbl by August 1986. In response to the price collapse OPEC adopted an emergency quota of 16.7 million b/d in September. This helped boost prices to over $13/bbl in September 1986 and up to over $17/bbl by January 1987.

Member countries seemed to learn something from the 1986 experience with the market. OPEC producers stayed close to their quota in 1987, and prices remained above $17/bbl for the year. But some difficulties developed. Iraq had managed to overcome the impact of the war on their production and exports, and their crude production was beginning to move up rapidly. They refused to be part of the adopted OPEC quota system. In addition, the UAE had internal problems satisfying the output demands of both Abu Dhabi and Dubai, and they also began producing above quota.

With this excess crude available in the market, when winter demand fell off in early 1988, prices started to slide again. Saudi Arabia adamantly refused to re-adopt the role of swing producer and instead boosted their own production. By October 1988, the prices of some OPEC export crudes had again fallen below $10/bbl.

It appears obvious that the key to sustaining an acceptable price level is OPEC adherence to a quota that comes close to balancing supply and demand. The problem for OPEC is finding a quota and allocation of production method that will satisfy all of its members.

OPEC REFINING CAPACITY

Country	1980	(Dec 31) 1982	1987	Change 1987-1982	% change 1987/1982
	(1,000 b/cd)				
Algeria	471.2	471.2	471.2	—	—
Ecuador	94.5	94.5	139.0	44.5	47.1
Gabon	44.0	44.0	21.0	−23.0	−52.3
Indonesia	473.4	473.4	738.7	265.3	56.0
Iran	1,320.0	670.0	615.0	−55.0	−8.2
Iraq	305.5	215.5	365.5	150.0	69.6
Kuwait	594.0	594.0	720.0	126.0	21.2
Libya	117.0	117.0	342.0	225.0	192.3
Nigeria	234.0	234.0	243.0	9.0	3.8
Qatar	10.5	13.0	63.0	50.0	384.6
Saudi Arabia	878.0	765.0	1,490.0	725.0	94.8
United Arab Emirates	13.5	121.5	162.0	40.5	33.3
Venezuela	1,444.9	1,323.1	1,258.3	−64.8	−4.9
Total OPEC	**6,000.5**	**5,136.2**	**6,628.7**	**1,492.5**	**29.1**

Source: OPEC Statistical Bulletin

OPEC PRODUCTION QUOTAS

Country	1984* quota	1984 production	1986 quota	1986 production	1988 quota	1988 production
	(1,000 b/d)					
Algeria	663	608	669	623	667	641
Ecuador	183	258	221	292	221	305
Gabon	137	150	160	159	159	175
Indonesia	1,189	1,423	1,193	1,238	1,190	1,138
Iran	2,300	2,174	2,317	1,848	2,369	2,240
Iraq	1,200	1,210	1,780	1,690	1,540	2,688
Kuwait	900	945	999	1,244	996	1,335
Libya	990	1,091	999	1,031	996	1,025
Neutral Zone	†	439	†	343	†	313
Nigeria	1,300	1,414	1,304	1,465	1,301	1,390
Qatar	280	396	300	332	299	346
Saudi Arabia	4,353	4,464	4,353	4,837	4,343	4,946
United Arab Emirates	950	1,159	950	1,330	948	1,474
Venezuela	1,555	1,711	1,574	1,642	1,571	1,649
Total	**16,000**	**17,442**	**16,819**	**18,074**	**16,600**	**19,665**

*Production quotas did not apply for full year †Quota does not apply to Neutral Zone. Production shared by Kuwait and Saudi Arabia

Source: OPEC and Author's estimates

OPEC RESERVES AND FUTURE PRODUCTION.

Looking at OPEC member country reserves and their reserves to production ratios, it is apparent that OPEC is split into 2 or 3 distinct groups.

Ranked by reserves, the top six OPEC countries have over 606 billion barrels of proven reserves. These six countries have 90.4% of OPEC reserves, 75% of non-communist reserves and 68.3% of total world reserves. Looking at their reserves to production ratios these individual countries all have close to or over 100 years of reserves. This is at the 1988–1989 rate of production.

The remaining eight OPEC countries have reserves equivalent to 10 to 55 years of current production. Libya is caught in the middle with about 55 years. Nigeria, Algeria and Qatar have 25–35 years, and the remainder have 20 years or less.

It is obvious that these groups have different short and long run objectives. The "big six" producing countries want a higher price for their crude oil, but they don't want to stifle the long run growth in world demand for petroleum. Their crude oil would have little value if conservation fuel switching and investment in alternative energy and energy efficiency leaves that oil in the ground. These countries are trying to find a production level that will provide sufficient current revenues but will still stimulate demand.

The other group cannot expect to sustain production at present levels for an extended period. They therefore are more interested in immediate revenue.

With the production capacity and reserves, it would appear that the "OPEC Big Six" will control OPEC policy. Under present economic conditions it would appear that the price they are looking for is $15–20/bbl. Getting to that price level and sustaining it is the dilemma now facing OPEC and the worldwide oil industry.